UNITED STATES AIR FORCE
611TH AIR SUPPORT GROUP
611TH CIVIL ENGINEER SQUADRON
ELMENDORF AFB, ALASKA

FINAL
WORK PLAN

INSTALLATION RESTORATION PROGRAM (IRP) REMEDIAL INVESTIGATION/ FEASIBILITY STUDY

KOTZEBUE LONG RANGE RADAR STATION, ALASKA

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RADAR STATION, ALASKA

OCTOBER 1994

PREPARED BY:

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NOTICE

NOTICE

This document has been prepared for the United States Air Force by Tetra Tech, Inc. to provide information regarding environmental conditions with respect to possible releases of hazardous substances at the Kotzebue Long Range Radar Station (LRRS), located 4 miles south of Kotzebue, Alaska. As the document relates to actual or possible releases of potentially hazardous substances, its release prior to an Air Force final decision on remedial action may be in the public's interest. The limited objectives of this report and the ongoing nature of the studies at Kotzebue LRRS, along with the evolving knowledge of site conditions and chemical effects on the environment and health, must be considered when evaluating this report, since subsequent facts may become known which may make this report premature or inaccurate. Acceptance of this report in performance of the contract under which it is prepared does not mean that the Air Force adopts the conclusions, recommendations or other views expressed herein, which are those of the contractor only and do not necessarily reflect the official position of the United States Air Force.

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ACRONYM LIST

AAC	Alaska Administrative Code
AAC	Alaskan Air Command
ADEC	Alaska Department of Environmental Conservation
AFB	Air Force Base
AFCEE	Air Force Center for Environmental Excellence
AKA	Also Known As
AOC	Area(s) of Concern
AQA	Air Quality Control (AK)
ARARs	Applicable or Relevant and Appropriate Requirements
ASTM	American Society of Testing and Materials
BETX	Benzene, ethylbenzene, toluene, xylene
BGS	Below Ground Surface
CAA	Clean Air Act
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CRP	Community Relations Plan
CWA	Clean Water Act
CZMA	Coastal Zone Management Act
DO	Dissolved Oxygen
DOD	Department of Defense
DQOs	Data Quality Objectives
DRMO	Defense Reutilization and Marketing Office
DTIC	Defense Technical Information Center
ENA	Engineering Network Analysis
EPA	Environmental Protection Agency
EQ	Ecological Quotient (Method)
ES	Engineering - Science, Inc.
ESA	Endangered Species Act
FSP	Field Sampling Plan
FWCA	Fish and Wildlife Coordination Act
HEAST	Health Effects Assessment Summary Tables
IRIS	Integrated Risk Information System
IRM	Interim Remedial Measure
IRP	Installation Restoration Program
IRPIMS	Installation Restoration Program Information Management System
ITIRs	Informal Technical Information Reports
LC50	Lethal Concentration, 50%
LOEL	Lowest Observable Effect Level
LRRS	Long Range Radar Station
LUFT	Leaking Underground Fuel Tank
MAP	Management Action Plan
MAR	Minimally Attended Radar
MPRSA	Marine Protection, Research and Sanctuaries Act

MSL	Mean Sea Level
NAB	Northwest Arctic Borough
NCP	National Contingency Plan
NOEL	No Observable Effect Level
NORAD	North American Air Defense Command
NTIS	National Technical Information Center
OHSPO	Oil and Hazardous Substances Pollution Control
OSHA	Occupational Safety and Health Act
OSWER	Office of Solid Waste and Emergency Response, (EPA)
PCBs	Polychlorinated biphenyls
PID	Photo-Ionization Detector
POL	Petroleum, oil, lubricants
POTW	Publicly Owned Treatment Works
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
RCA	Radio Corporation of America
RCRA	Resource Conservation and Recovery Act
RfD	Reference Dose
RI/FS	Remedial Investigation/Feasibility Study
ROCC	Region Operations Control Center
SAP	Sampling and Analysis Plan
SARA	Superfund Amendments and Reauthorization Act
SOP	Standard Operating Procedure
SVOC	Semi-Volatile Organic Compounds
SWM	Solid Waste Management (AK)
TOC	Total Organic Carbon
TPH	Total Petroleum Hydrocarbons
TSCA	Toxic Substances Control Act
USAF	United States Air Force
USGS	United States Geological Survey
VOC	Volatile Organic Compounds
WACS	White Alice Communications System
WCC	Woodward Clyde Consultants
WP	Work Plan
WQS	Water Quality Standards (AK)

1.0 INTRODUCTION

Tetra Tech, Inc., under contract to the United States Department of the Air Force (USAF), has been requested to conduct a remedial investigation/feasibility study (RI/FS) at the Kotzebue Long Range Radar Station (LRRS), Kotzebue, Alaska. The RI/FS will be conducted under the authority of the USAF Installation Restoration Program (IRP) and under direction of the Air Force Center for Environmental Excellence (AFCEE).

This document is the work plan prepared for the Kotzebue LRRS, Alaska. This work plan describes the work to be performed, explains project objectives, and presents the rationale for conducting specific project activities. All information in this work plan has been prepared according to the May 1992 version of the Handbook to support The Installation Restoration Program (IRP) Statements of Work, Volume I-Remedial Investigation/Feasibility Studies (RI/FS), (U.S. Air Force Reprint, 22 May 1992), hereinafter referred to as the IRP Handbook.

1.1 OBJECTIVES AND PURPOSE OF THE INSTALLATION RESTORATION PROGRAM

1.1.1 Objectives and Purpose of the Installation Restoration Program

The objective of the U.S. Air Force IRP is to assess past hazardous waste disposal and spill sites at U.S. Air Force installations, and to develop remedial actions consistent with the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) for those sites which pose a threat to human health and welfare of the environment. Over the years, requirements of the IRP have been developed to ensure Department of Defense (DOD) compliance with federal laws such as the Resource Conservation and Recovery Act (RCRA), NCP, Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), and Superfund Amendments and Reauthorization Act (SARA).

To ensure compliance with the following regulations, DOD developed the IRP. The IRP was initiated so that DOD could identify potentially contaminated sites, investigate these sites, and evaluate and select remedial actions for potentially contaminated facilities.

The NCP was issued in 1980 to provide response guidance and a process by which contaminant release could be reported, contamination could be identified and quantified, and remedial actions could be selected. The NCP describes the responsibility of federal and state governments, and those responsible for contaminant releases. In 1980, Congress enacted CERCLA. CERCLA outlines the responsibility for identifying and remediating contaminated sites in the United States and its possessions. CERCLA identified the EPA as the primary policy and enforcement agency regarding contaminated sites. Executive Order 12316, adopted in 1981, gave various federal agencies, including DOD, the responsibility to act as lead agencies to conduct investigations and implement remedial efforts when they are the sole or co-contributor to contamination on or off their properties.

SARA of 1986 extends the requirements of CERCLA, and modifies CERCLA with respect to goals for remediation and the process leading to the selection of a remedial technology. SARA is the primary legislation governing remedial action at past hazardous waste disposal sites. Under SARA, technologies that provide permanent removal or destruction of a contaminant are preferable to actions that contain or isolate the contaminant. SARA also provides for greater interaction with the public and state agencies, and extends EPA's role in evaluating health risks associated with contamination. Under SARA, early determination of Applicable or Relevant and Appropriate Requirements (ARARs) is required, and potential remediation alternatives are considered at the initiation of an RI/FS.

The IRP is DOD's primary mechanism for response actions on U.S. Air Force installations affected by the provisions of SARA. In November 1986, in response to SARA and other EPA interim guidance, the U.S. Air Force modified the IRP to provide for an RI/FS program. The IRP is designed so that the RI and the FS are conducted as parallel activities, rather than as serial activities. The program now includes ARAR determinations, identification and screening of technologies, and development of alternatives. The IRP may include multiple field activities and pilot studies prior to a detailed final analysis of alternatives. Over the years, requirements of the IRP have been developed to ensure DOD compliance with federal laws such as the NCP, CERCLA, and SARA.

The objectives of the IRP are to:

- Identify and evaluate sites where contamination may be present on DOD property because of past hazardous waste disposal practices or spills;
- Control the migration of hazardous contaminants; and
- Control health hazards or hazards to the environment that may result from past DOD operations.

The IRP was developed so that these objectives could be met in accordance with the NCP, CERCLA, and SARA. Solutions that are developed should provide the level of protection necessary to protect public health and the environment, meet the requirements of ARARs, be technically feasible to implement at a site, and be cost effective.

1.2 HISTORY OF PAST IRP WORK CONDUCTED AT KOTZEBUE LRRS

This section presents a description of Kotzebue LRRS, a summary of past IRP work conducted at the installation, a discussion regarding issues and concerns of the Alaska Department of Environmental Conservation (ADEC), and a description of the recent site survey conducted by Tetra Tech and Air Force personnel at Kotzebue LRRS.

1.2.1 Installation Description

Kotzebue LRRS is located on 676 acres of land adjacent to Kotzebue Sound. The installation is located approximately 610 miles northwest of Anchorage and 450 miles west-northwest of Fairbanks (Figure 1-1). The City of Kotzebue, Alaska, accessible by road 4 miles north of the site, has a population of approximately 3600 (Figure 1-2).

Kotzebue LRRS was originally built as a temporary aircraft control and warning site to fill a radar coverage gap while two permanent sites were being built at Cape Lisburne and Tin City, Alaska. Kotzebue LRRS was equipped with a lightweight search radar when it first became operational in 1950.

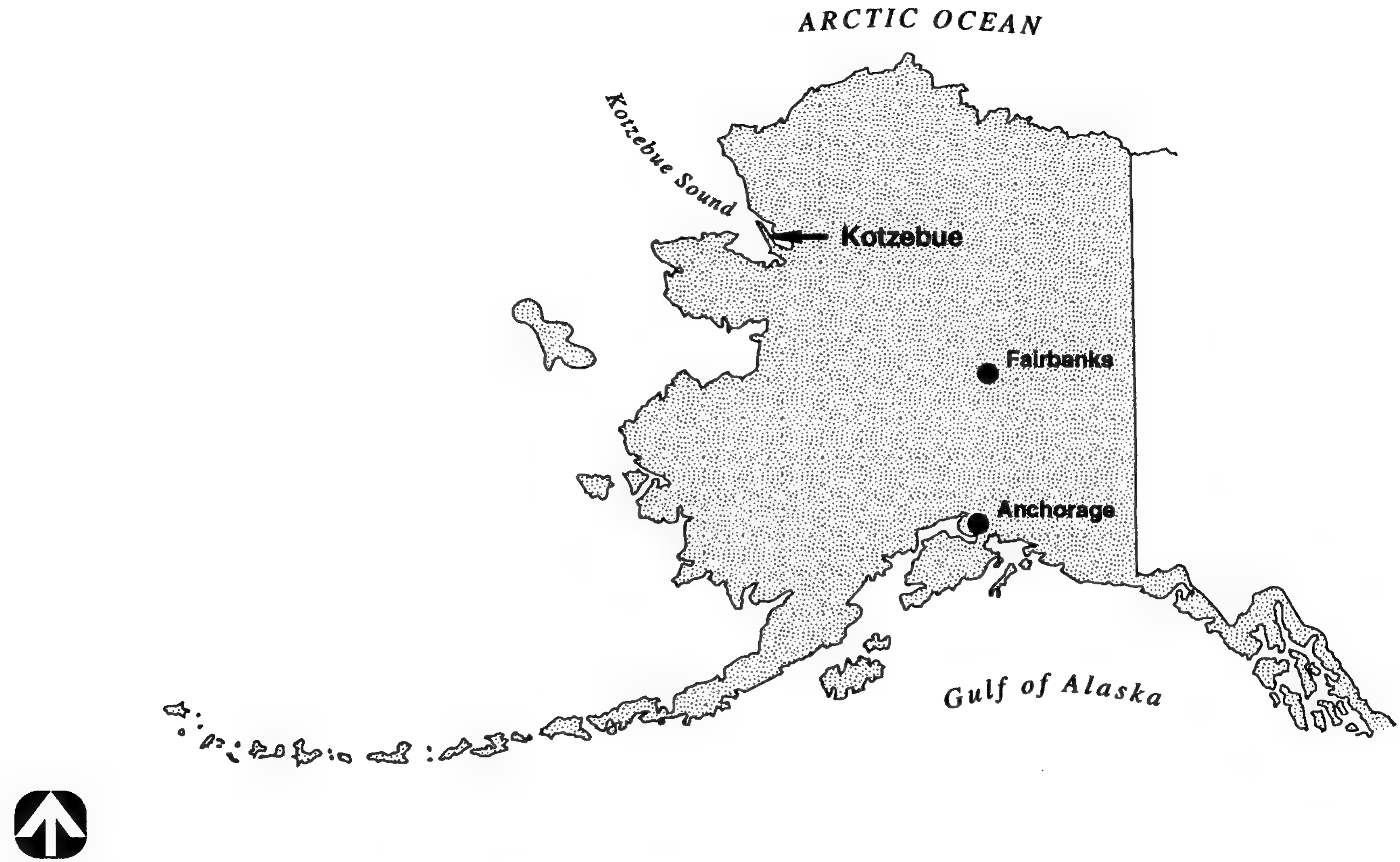


Figure 1-1. Location Map, Kotzebue, Alaska.

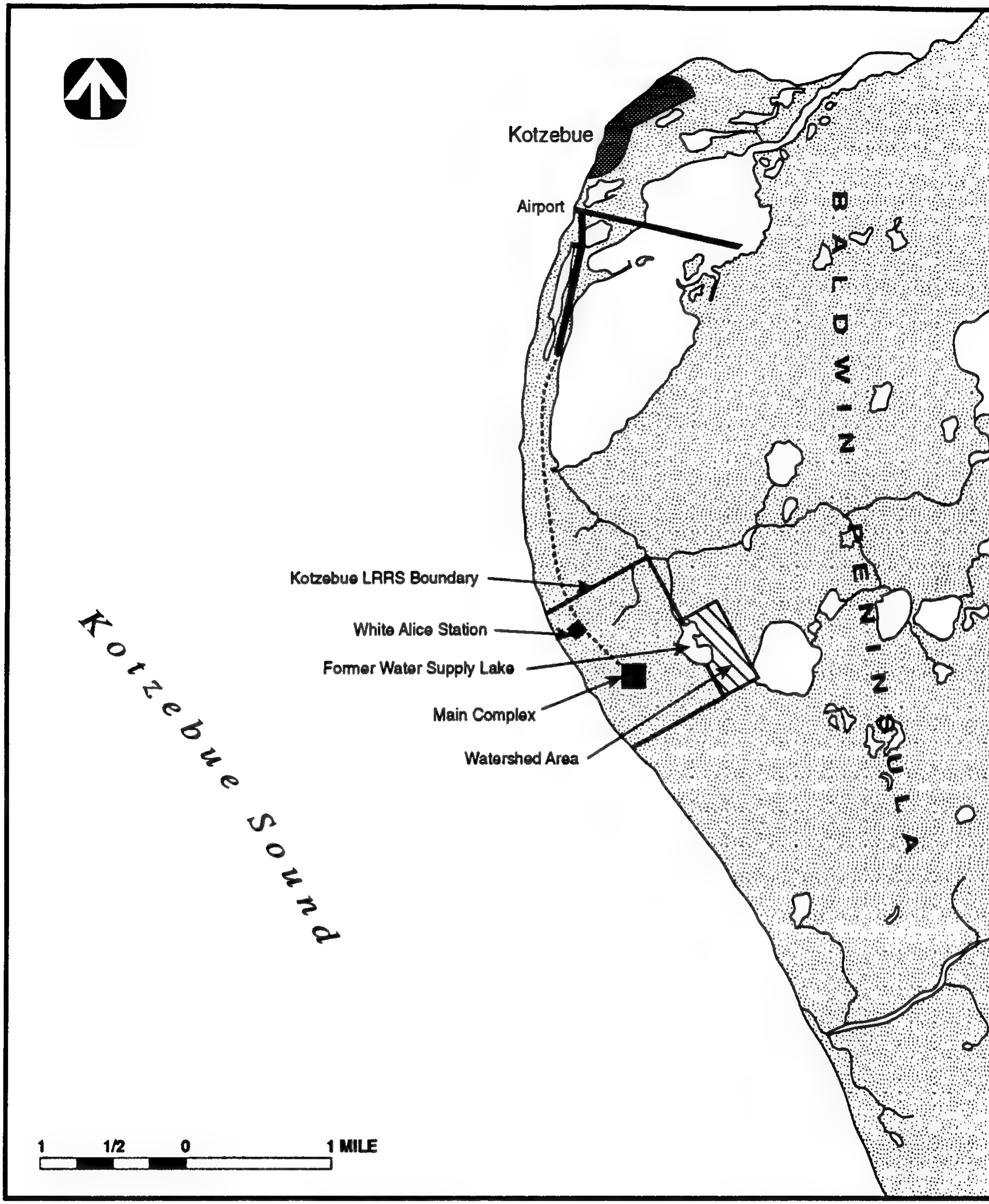


Figure 1-2. Area Location Map, Kotzebue Long Range Radar Station (LRRS), Alaska.

In 1954, the Alaskan Air Command (AAC) decided to convert the site into a permanent station. Construction of permanent facilities was completed in 1958. The station operated as a ground-controlled intercept site until 1973, when it was converted to a North American Air Defense Command (NORAD) surveillance station. Communications for Kotzebue LRRS were provided by White Alice Communication Systems (WACS) from 1957 until 1979, when a commercial satellite station replaced WACS. In 1977, AAC signed a base operating support contract with RCA Services as part of an Air Force-wide effort to reduce remote tours. Sixty-nine military positions were eliminated and 16 operations positions remained. Installation of Joint Surveillance System (JSS) equipment was completed in 1982, enabling radar and beacon data to be transmitted by satellite to the Elmendorf Region Operations Control Center (ROCC). These operation modifications left only contractor personnel to maintain the radar. A Minimally Attended Radar (MAR) system was installed in 1985 that enabled deactivation of the site, with the exception of the radome. Two radar maintenance technicians working separate shifts are currently housed in the nearby City of Kotzebue (WCC 1990a). Additional personnel provide maintenance on an as-needed basis. Figure 1-3 provides an illustration of the Kotzebue LRRS facility.

Past operations such as radar and vehicle shop maintenance at Kotzebue LRRS generated wastes, including waste oils and spent solvents; waste oils were drummed and stored in waste accumulation areas within facility boundaries (WCC 1990a). Some waste oils were used for ground application (dust control) on roads. A waste accumulation area and installation landfill, both located adjacent to Kotzebue Sound, were used to store and dispose of facility wastes. Potential contaminants associated with base operations include waste oil, fuels, solvents, herbicides, and pesticides. In 1972, the waste accumulation area was closed, and in 1974 the landfill was closed. The waste accumulation area and landfill were cleaned and regraded, and drummed wastes were removed from the installation in 1975. Fuels management at Kotzebue LRRS included diesel fuel storage in large above-ground storage tanks located adjacent to Kotzebue Sound. These tanks provided fuel to smaller fuel tanks located adjacent to the composite facility. The beach fuel storage tanks were removed in 1992. The smaller fuel tanks located adjacent to the composite facility are still in place, but were inspected and emptied of any residual product in 1993.

1.2.2 Previous Investigative Activities and Documentation

This section provides a chronologic summary of past to present IRP activities conducted at Kotzebue LRRS. Summary tables and figures are presented to identify and describe sites, and to provide a common

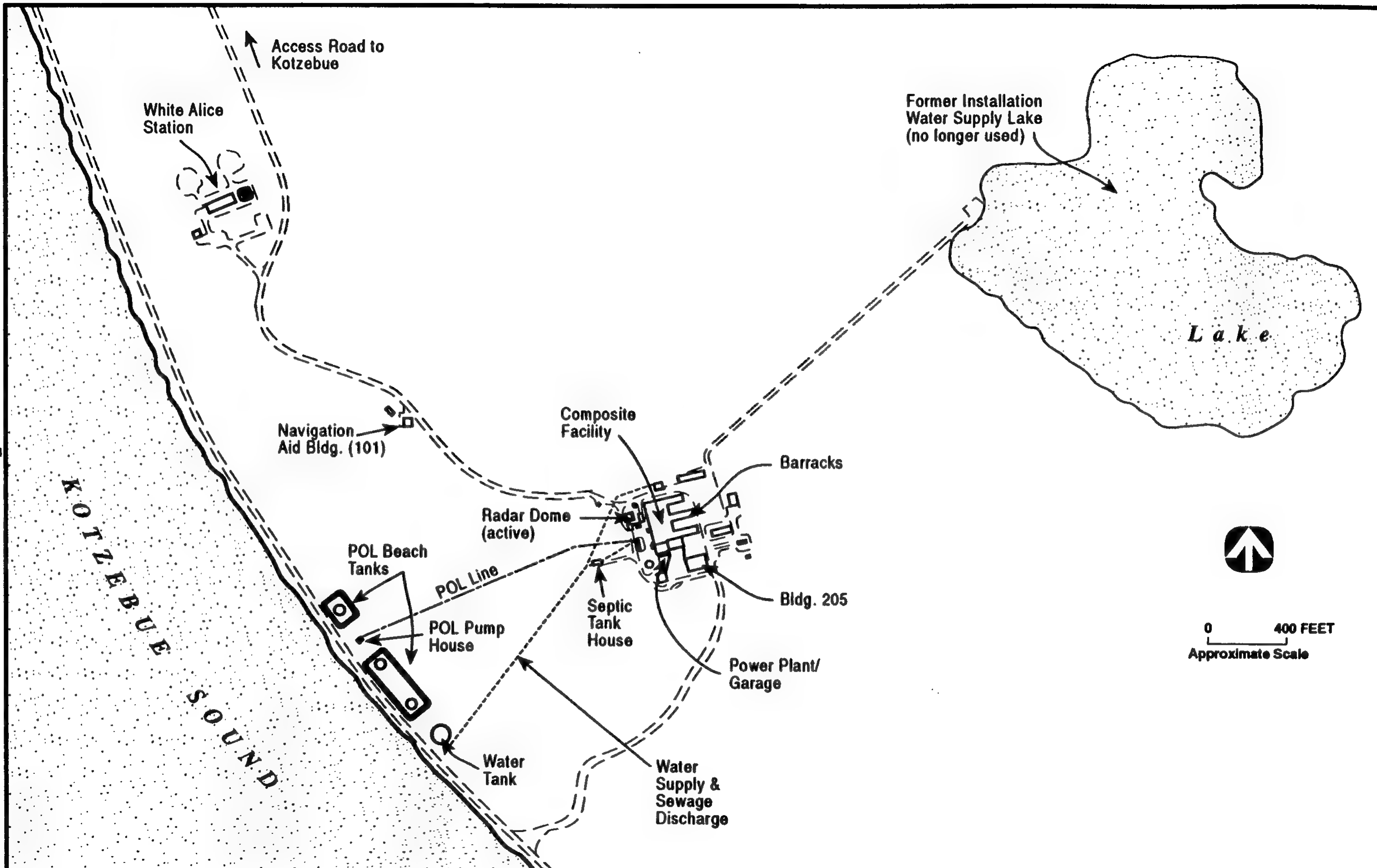


Figure 1-3. Facility Map. Kotzebue LRRS, Alaska.

frame of reference regarding all past environmental characterization and associated analytical results obtained for Kotzebue LRRS.

1.2.2.1 Phase I Records Search. In 1985, Engineering - Science (ES) conducted a Phase I Records Search for the AAC Northern Region, which includes Kotzebue LRRS. The purpose of the Phase I records search was to identify and prioritize past disposal sites that may pose a hazard to public health or the environment as a result of contaminant migration to surface water or groundwater, and to identify contaminants that could have an adverse effect due to their persistence in the environment. Twelve sites were identified from a review of base records, interviews with current and former employees, information gathered during field surveys, and from interviews with local, state, and federal agency representatives. Based on an additional assessment of factors such as site characteristics, waste characteristics, and the potential for contaminant migration, eight sites were identified for further IRP evaluation (ES 1985).

1.2.2.2 Stage 1 RI/FS. In 1988, Woodward-Clyde Consultants (WCC) conducted a Stage 1 Remedial Investigation/Feasibility Study (RI/FS) to assess past hazardous materials disposal and spill sites at Kotzebue LRRS, and to develop remedial action(s) for sites thought to pose a threat to human health and welfare or to the environment. Twelve sites were initially identified for investigation by WCC, including the eight sites previously identified during the Phase I Records Search. Based on a 1987 field reconnaissance conducted by WCC and USAF personnel, two sites were excluded from investigation based on a lack of evidence regarding contamination and environmental stress (WCC 1990a). Table 1-1 provides a description of sites identified by WCC. Figure 1-4 provides an installation diagram identifying site locations.

The Stage 1 RI was conducted at 10 sites, and included soil/sediment sampling at all sites, surface water sampling at site SS07-Lake, a soil gas survey conducted at the SS12-Spills No. 2 and 3 sites, water-flooding pilot testing at the SS12-Spill No. 3 site, and aeration of soils at the SS11-Fuel Spill site.

Analyses conducted on soil and surface water samples collected during the Stage 1 RI are summarized in Table 1-2. Analytical results indicate that total petroleum hydrocarbons (TPH) constitute the primary soils contamination problem at Kotzebue LRRS. Additionally, polychlorinated biphenyls (PCBs), pesticides, and benzene, ethylbenzene, toluene/xylene (BETX) were detected in soil samples. No organic compounds were detected above laboratory detection limits in a surface water sample collected from the

TABLE 1-1. 1988 STAGE 1 RI/FS SITE IDENTIFICATION

USAF Site Designation[a]	WCC Site Designation	Site Name	Site Descriptions
SS01	KOT-4	Waste Accumulation Area No. 1	This site is located south of Building No. 205, west of the installation access road. The site is an approximate 80x160 ft gravel pad formerly used to store drummed waste oils and/or solvents.
SD03	KOT-3	Road Oiling	Waste oils, spent solvents, ethylene glycol, and other shop wastes were reportedly used for dust control on the installation road system. The use of waste oil for dust control was practiced until 1984.
ST05	KOT-8	Beach Tanks	The site is located approximately 0.25 miles southwest of the Composite Facility. The site is associated with the former POL (diesel fuel) storage tanks located adjacent to Kotzebue Sound and comprises an area of approximately 250x900 ft.
SS07	KOT-7	Lake	The lake is located approximately 0.25 miles northeast of the Composite Facility. The lake served as the installation drinking water supply until 1985.
SS08	KOT-6	Barracks Pad	The site is located adjacent to the Composite Facility, between two building wings. The site is an approximate 25 x 40 ft gravel pad reportedly used to store chemicals such as solvents, rust inhibitors, chlorobromomethane, and various fluorocarbons. Small above ground diesel fuel tanks located adjacent to the barracks pad are reportedly a potential source of diesel fuel contamination.
SS09	KOT-5	PCB Spill	The site is located at the White Alice Station, approximately 0.5 miles northwest of the Composite Facility. A PCB spill reportedly occurred on a portion of a 10 x 10 ft gravel pad.
SS10	KOT-5	Solvent Spill	The site is located at the White Alice Station, approximately 0.5 miles northwest of the Composite Facility. A solvent spill had reportedly occurred covering an approximate 10 x 20 ft area on the edge of a gravel pad.
SS11	KOT-5	Fuel Spill	The site is located at the White Alice Station, approximately 0.5 miles northwest of the Composite Facility. A jet fuel spill reportedly occurred which covered an approximate 50 x 60 ft area.
SS12	KOT-1	Spill No. 2	The site is located west-southwest of the Composite Facility power plant. A diesel fuel spill reportedly occurred in 1979-1980 when the day tank behind the power plant was overfilled.
SS12	KOT-1	Spill No. 3	The site consists of an approximate 1.5 acre area adjacent to, and west-southwest of, the Composite Facility. A large diesel fuel leak reportedly occurred via a hole in a distribution line identified in 1984. The fuel line was repaired, and approximately 4,000 gal of diesel fuel was reportedly collected in recovery trenches subsequently installed by the Air Force.
EXCLUDED SITES			
SS02	KOT-2	Waste Accumulation Area No. 2 /Landfill	The landfill is located on a triangular piece of land adjacent to and north of the former fuel storage tanks on the beach. Waste accumulation Area No. 2 is located northeast of the former fuel storage tanks adjacent (south) to the landfill. The landfill was used until approximately 1974. Waste accumulation Area No. 2 was used until approximately 1972; in 1975, the site was cleaned up and the area graded.
SS06	KOT-1	Spill No. 1	The site is located near the officers wing of Building 103 (northern most wing). A diesel fuel leak reportedly occurred in a fuel line in the mid-1970's due to a coupling failure.

[a] USAF Site Designation to be used as standard format.

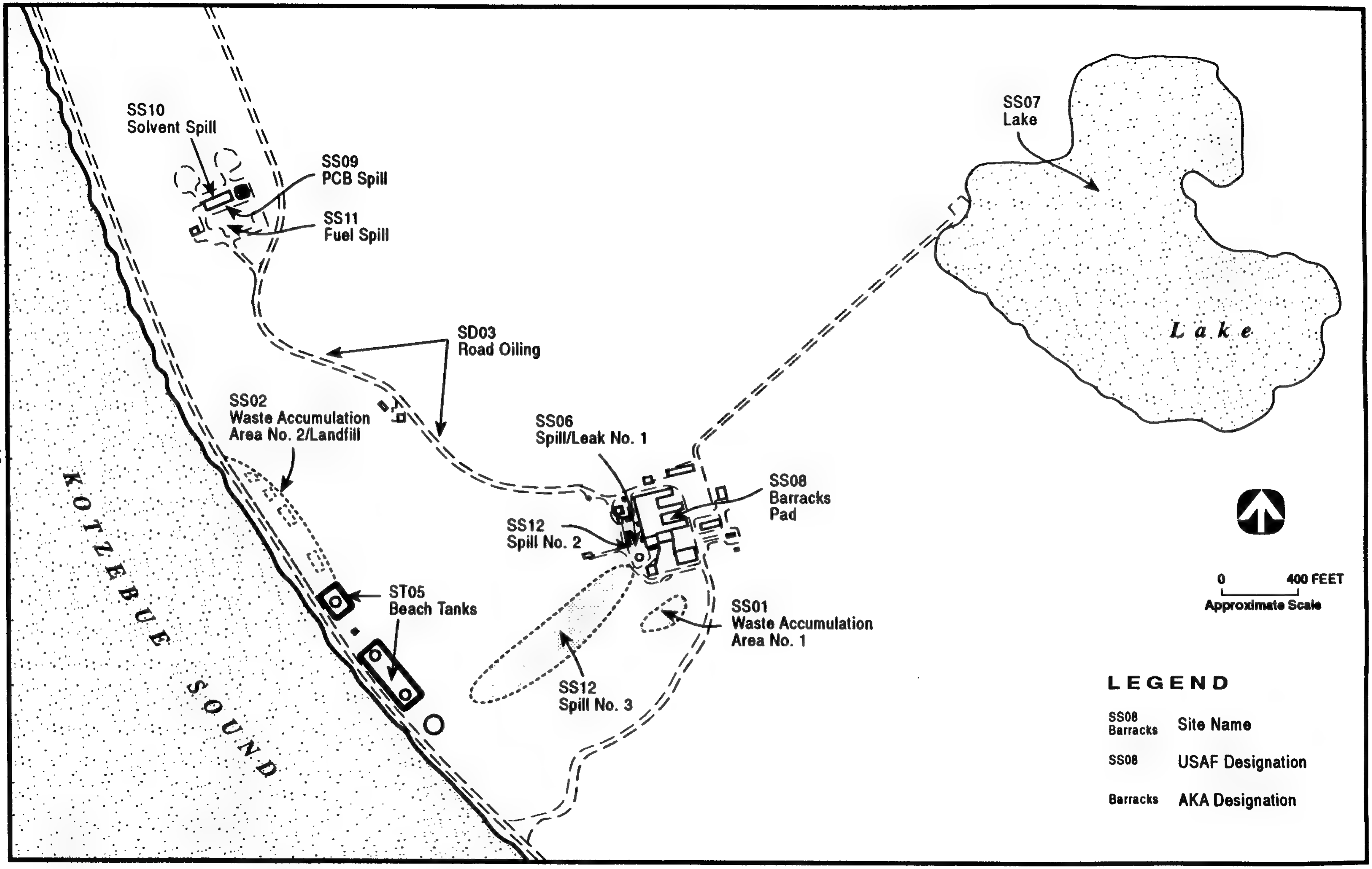


Figure 1-4. Stage 1 RI/FS Site Designation Map, Kotzebue LRRS, Alaska.

TABLE 1-2. SOIL AND SURFACE WATER SAMPLE ANALYTES COLLECTED DURING 1988 STAGE 1 RI/FS

Analyte	Analytical Method	Site Identification
Soils/Sediment		
Total Petroleum Hydrocarbons	SW3550/E418.1	All 10 sites
Metals Screen by ICP (23 metals, exclude boron & silica)	SW3050/SW6010	SD03-Road Oiling, SS01-Waste Accumulation Area No. 1
Organochlorine Pesticides and PCBs	SW3550/SW8080	All sites except ST05-Beach Tanks
Volatile Organic Compounds	SW8240	All sites except SS09-PCB Spill
Soil Moisture Content	ASTM D-2216	All 10 sites
Surface Water		
Total Petroleum Hydrocarbons	E418.1	SS07-Lake
Metals Screen (23 metals) by ICP	SW3005/SW6010	SS07-Lake
Purgeable Halocarbons	SW5030/SW8010	SS07-Lake
Purgeable Aromatics	SW5030/SW8020	SS07-Lake
Organochlorine Pesticides and PCBs	SW3510/SW8080	SS07-Lake
Extractable Priority Pollutants	SW3510/SW8270	SS07-Lake

former water supply lake. However, the pesticide 4,4'-DDT (2.6 mg/kg) and the PCB Aroclor 1260 (3.4 mg/kg) were detected in a sediment sample collected from the former water supply lake. Metals concentrations identified in soils and surface waters are reported to be within the typical range for those constituents in the contiguous United States (WCC 1990a). Maximum concentrations of organic compounds and metals identified in site soils and surface waters are provided in Table 1-3 as presented in the Stage 1 RI/FS Final Report.

A soil gas survey was conducted at the SS12-Spills No. 2 and 3 sites to provide a qualitative assessment of the extent of petroleum contamination adjacent to the site. However, the soil gas data are reportedly non-quantifiable, primarily due to the extreme variability of soil moisture content within soils (WCC 1990a). Water-flooding pilot studies were conducted at the SS12-Spill No. 3 site in an attempt to recover free product from contaminated soils. Study results indicate that water-flooding is not a viable remedial alternative; this conclusion was based on inadequate volumes of free-product at the site and the low permeability of site soils (WCC 1990a).

Identified contaminants of concern, including TPH, PCBs, and the organochlorine herbicides/pesticides delta BHC, 4,4'-DDT, 4,4'-DDE, and 4,4'-DDD, were evaluated with respect to state and federal cleanup standards and health and environmental criteria. A qualitative two-tiered health and environmental risk screening approach was developed to identify those sites warranting further consideration regarding remedial actions. Based on the risk screening criteria and methodology used, no Kotzebue LRRS sites reportedly posed significant health or environmental risks (WCC 1990a). Recommended cleanup levels, developed for contaminated soils based on federal criteria and a modified California leaking underground fuel tank (LUFT) manual scoring procedure for TPH, were as follows (WCC 1990a):

Contaminant	Concentration (mg/kg)
TPH (ST05-Beach Tanks)	1,000
TPH (All other sites)	10,000
PCBs	10
Benzene	1
Ethylbenzene	50
Toluene	50
Xylene	50

TABLE 1-3. 1988 STAGE 1 RI/FS SUMMARY OF MAXIMUM ORGANIC AND INORGANIC COMPOUND CONCENTRATIONS DETECTED IN SOIL AND SURFACE WATER AT KOTZEBUE LRRS

USAF Site Designations	Media	TPH[a] (mg/kg)	Pesticides (mg/kg)				Organic Compounds and Peak Concentrations (mg/kg)				
			4,4'-DDD	4,4'-DDE	4,4'-DDT	Delta-BHC	PCBs Aroclor 1260	Benzene (mg/kg)	Ethylbenzene (mg/kg)	Toluene (mg/kg)	Total Xylenes (mg/kg)
***Maximum Organic Compound Concentrations in Soil[c]**											
SS12-Spill No. 2	Soil	10,700	0.027	ND[b]	0.14	ND	ND	ND	1.2	1.0	47
SS12-Spill No. 3	Soil	99,200	2.3	ND	5.7	0.11	ND	0.86	22	28.0	170
SDO3-Road Oil	Soil	97	0.37	ND	ND	ND	ND	ND	ND	ND	ND
SS01-Waste Acc. Area No. 1	Soil	16,200	0.98	ND	ND	ND	ND	ND	ND	ND	ND
SS11-Fuel Spill	Soil	23,100	ND	ND	0.098	ND	ND	ND	ND	5.9	200
SS10-Solvent Spill	Soil	1,460	ND	ND	0.22	ND	25.0	ND	ND	ND	ND
SS09-PCB Spill	Soil	4,600	ND	ND	0.062	ND	32.0	ND	ND	ND	ND
SS08-Barracks	Soil	5,960	0.19	ND	ND	ND	ND	ND	ND	ND	ND
SS07-Lake	Sediment	ND	1.10	0.19	2.6	ND	3.4	ND	ND	ND	ND
	Surface Water	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ST05-Beach Tanks	Soil	5,300	NA[d]	NA	NA	NA	NA	ND	ND	6.2	ND

***Maximum Inorganic Compound Concentrations in Soil and Water**

	Media	Inorganic Compounds														
		Aluminum	Barium	Beryllium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Nickel	Sodium	Vanadium	Zinc
SD03 (Road Oil) (mg/kg)	Soil	8,800	170	0.4	3,300	15	8	15	14,200	8	3,400	230	18	50	20	36
SS01 (Waste No. 1) (mg/kg)	Soil	3,800	95	0.1	27,900	13	6	11	13,300	8	12,000	590	29	90	14	120
SS07 (Lake) (mg/L)	Surface Water	ND	0.05	ND	17	ND	ND	ND	10	ND	5.2	0.02	ND	3.3	ND	0.01

[a] TPH = Total petroleum hydrocarbons.
[b] ND = Concentration below detection limit.
[c] Soil contaminant values are reported as "dry weight" results.
[d] NA = Not analyzed.
*Data Quality Assurance/Quality Control (QA/QC) validation discussed in Section 4.2, 1988 Stage 1 RI/FS Final Report.

Despite the absence of significant health or environmental risks identified in the risk screening process, WCC (1990a) recommended several sites for further remedial action based on soil analyses indicating contamination above recommended cleanup levels, including the SS12-Spill No. 2, SS12-Spill No. 3, SS01-Waste Accumulation Area No. 1, SS09-PCB Spill, SS10-Solvent Spill, SS11-Fuel Spill, and ST05-Beach Tanks Sites.

WCC conducted an FS to evaluate remedial technologies and identify appropriate remedial alternatives. Four distinct operable units were defined to create a logical division of site contamination problems while providing an appropriate means for remedial assessment. Table 1-4 provides a description of operable units and a summary of remedial alternatives selected by operable unit for sites recommended for further remedial action.

1.2.2.3 Stage 2 RI/FS. In 1989-1990, WCC conducted a Stage 2 RI/FS program at Kotzebue LRRS to address the sites recommended for remedial action based on the findings of the Stage 1 RI/FS. Field activities conducted between July 1989 and September 1990 included pilot-scale remediation tests involving excavation and landfarming, *in situ* enhanced bioremediation, excavation and off-site disposal of PCB contaminated soils, the removal of four transformers, and an investigation of soil and groundwater at the STO5 Beach Tank site.

As in the Stage 1 RI/FS, total petroleum hydrocarbon (TPH) concentrations were established using U.S. EPA Method 418.1 for the analysis of samples collected as part of the Stage 2 RI/FS. Several limitations exist regarding the use of TPH concentrations obtained using Method 418.1, primarily because this method does not establish concentrations for individual compounds that comprise the TPH concentration. Detections of TPH in samples using Method 418.1 can be the result of the natural organic content of the sample, anthropogenic petroleum-based contamination, or a combination of the two. This makes it difficult (or impossible) to evaluate the relationships between TPH concentrations in different media, source areas, and for samples collected at different times from the same location.

A landfarm was constructed on a level pad (part concrete and part fill) on the east side of the installation access road, directly east of the Composite Facility. TPH contaminated soils and fill were excavated from the SS01-Waste Accumulation Area No. 1 (approximately 50 yd^3), the SS12-Spill No. 2 (approximately 100 yd^3), and the SS12-Spill No. 3 (approximately 350 yd^3) sites, and were stockpiled on 6 mil

TABLE 1-4. OPERABLE UNIT DESCRIPTION AND REMEDIAL ALTERATIVE SELECTION SUMMARY FOR WCC STAGE 1 AND STAGE 2 RI/FS INVESTIGATIONS

Operable Unit	Operable Unit Description	Remedial Alternatives Selected for Detailed Analysis	Selected Remedial Alternative
Operable Unit A - Soils/Fill Material			
SS12 - Spill No. 2 and 3 SS01 - Waste Accumulation Area No. 1	Sites in this operable unit have been selected based on the nature of the existing soils. Kotzebue LRRS consists of various buildings, roads, and pads to facilitate overlain site operations. In these areas, the native tundra has been replaced with fill material, and excavation activities to remove contamination could proceed without further damage to the native tundra.	- Non Action/Institutional Controls - Capping - Excavation/On-Site Thermal Treatment - Excavation/On-Site Landfarming - Excavation/Transportation/Reclamation	- Excavation/On-Site Landfarming
Operable Unit A - Beach Sands and Gravels/Fill			
STO5 - Beach Tanks	This operable unit includes the beach sands and gravels west of the access road at the ST05 site, as well as fill material that was imported to the site to construct the tank pads (generally beach sands and gravels). Alternatives developed for this operable unit are designed to minimize disruptions to the beach.	- Non Action/Institutional Controls - Excavation/Landfarming - Soil Vapor Extraction - In-Situ Bioremediation (no groundwater recapture)	- In-Situ Bioremediation (no groun dwater recapture)
Operable Unit B - Soils/Native Tundra			
SS12 - Spill No.3 SS11 - Fuel Spill	Sites in this operable unit have an intact tundra ground cover, although part of the site may consist of fill material. Alternatives developed for this operable unit are designed to minimize further disruptions to the tundra.	- Non Action/Institutional Controls - In-Situ Enhanced Biodegradation	- In-Situ Enhanced Biodegradation
Operable Unit C - Soils with PCBs			
SS09 - PCB Spill SS10 - Solvent Spill	Soils containing PCB contamination were identified as a separate operable unit in order to address technologies specific to PCB remediation.	- Non Action/Institutional Controls - Excavation/Off-Site Disposal - In-Situ Enhanced Biogradation	- Excavation/Off-Site Disposal
Operable Unit D - Groundwater			
STO5 - Beach Tanks	This operable unit is the groundwater beneath the beach sands and gravels at the STO5 site.	- Non Action/Institutional Controls - In-Situ Closed Loop Bioremediation - In-Situ Bioremediation (no ground-water recapture)	- In-Situ Bioremediation (no groundwater recapture)

plastic within the landfarm area. Soils were spread, and emulsification (Toxigon™) and micronutrient agents (Medina™) were applied. The landfarm was mixed weekly over the course of two field seasons (1989-1990) to promote microbial activity, and was subsequently sampled over the course of the two field seasons on an intermittent basis to evaluate TPH reductions.

In situ enhanced bioremediation activities were conducted at the SS12-Spill No. 3 and the SS11-Fuel Spill sites, and included areal applications of emulsifiers and micronutrients. Additionally, treatment infiltration trenches were installed at the SS12-Spill No. 2 Site. Emulsifiers and micronutrients were added to the infiltration trenches in an attempt to degrade TPH in soils surrounding pipes, pumps, tanks, and fencing.

PCB contaminated soils were excavated from two White Alice Sites (SS09-PCB Spill and SS10-Solvent Spill Sites). An estimated 5.3 yd^3 of contaminated soil from Site SS09 and 7.8 yd^3 from Site SS10 were excavated, placed in 55 gallon drums, and shipped to the Defense Reutilization and Marketing Office (DRMO) at Elmendorf AFB. Confirmation soil samples were collected in each excavation to document complete PCB removal.

Soil and groundwater at the STO5-Beach Tanks Site were characterized for the purpose of quantifying the nature and magnitude of contamination, delineating the horizontal and vertical extent of contamination, determining the hydrogeologic setting, and completing an FS of remedial alternatives.

Analyses conducted on soil and groundwater samples collected during the Stage 2 RI/FS are presented in Table 1-5. Analytical results for PCB confirmation soil samples collected from the base and sides of the excavations of the SS09-PCB Spill and SS10-Solvent Spill Sites indicate PCB concentrations below cleanup goals, with maximum residual concentrations of 1.3 mg/kg and 3.7 mg/kg, respectively, for the two sites. Soil samples collected during landfarm and *in situ* enhanced bioremediation activities exhibit a mean reduction in TPH concentrations over time. Table 1-6 presents TPH concentrations measured in samples obtained during the landfarm and *in situ* enhanced bioremediation programs (as presented in the December 1990 Stage 2 RI/FS Report; WCC 1990b). The mean reductions in TPH concentrations observed in landfarm soils over time are probably the result of biological degradation, volatilization, and leaching processes (WCC 1990b). Volatilization was not considered a significant loss mechanism because: 1) volatile components would likely have dissipated from the spill prior to the study; 2) the

TABLE 1-5. SOIL AND GROUNDWATER SAMPLE ANALYTES COLLECTED DURING 1989-1990 STAGE 2 RI/FS

Analyte	Analytical Method	Site Identification
Soils		
Total Petroleum Hydrocarbons	SW3550/E418.1	ST05-Beach Tanks, Landfarm, SS12-Spill No. 3, SS11-Fuel Spill
Polychlorinated Biphenyls	SW3550/SW8080	SS-11 Fuel Spill, SS09-PCB Spill
Semivolatile Organics	SW3550/SW8270	ST05-Beach Tanks
Microbial Enumeration (total, viable, and phenanthrene-specific)	Hobbie et al. 1977	ST05-Beach Tanks, Landfarm
Soil Moisture Content	ASTM D2216	All sites
Permeability	USCOE Manual EM 110-2-1906 App. VII and X (30 Nov. 1970)	ST05-Beach Tanks
Soil Gradation	ASTM D 422-63 (1972)	ST05-Beach Tanks
Groundwater		
Total Petroleum Hydrocarbons	E418.1	ST05-Beach Tanks
Purgeable Aromatics	SW5030/SW8020	ST05-Beach Tanks
Semivolatile Organic Compounds	SW3510/SW8270	ST05-Beach Tanks
Biochemical Oxygen Demand	E 405.1	ST05-Beach Tanks
Chemical Oxygen Demand	E 410.4	ST05-Beach Tanks
Total Dissolved Solids	E 160.1	ST05-Beach Tanks
Microbial Enumeration (total, viable, and phenanthrene-specific)	Hobbie et al. 1977	ST05-Beach Tanks

TABLE 1-6. TOTAL PETROLEUM HYDROCARBON CONCENTRATIONS IN SOIL SAMPLES COLLECTED FROM THE LANDFARM, NATIVE TUNDRA, AND DISTURBED TUNDRA, KOTZEBUE LRRS, AUGUST-SEPTEMBER 1989 AND JULY-SEPTEMBER 1990.

Sampling Date	Number of Samples	Mean Concentration (mg/kg)	Standard Deviation	Standard Error
LANDFARM SITE				
August 8, 1989	9	9,656	3,946	1,315
September 12, 1989	9	5,237	1,385	462
September 26, 1989	9	5,919	2,602	867
July 25, 1990	10	4,044	567	179
September 24, 1990	10	2,359	551	174
NATIVE TUNDRA (SS12-Spill No. 3 Site)				
August 8, 1989	5 4[a]	6,018 7,500	5,513 5,088	2,465 2,544
September 12, 1989	5	5,338	7,363	3,293
September 26, 1989	5	5,338	7,363	625
July 24, 1990	10	3,118	2,199	695
September 24, 1990	10 9[b]	2,044 1,306	2,604 1,230	824 410
DISTURBED TUNDRA (SS11-Fuel Spill Site)				
August 8, 1989	5	6,310	1,709	764
September 12, 1989	5	1,597	1,533	686
September 26, 1989	5	726	608	272
July 25, 1990	10	1,013	469	148
September 24, 1990	10	575	603	191

[a] If one analysis of 90 mg/kg is removed as an apparent outlier.

[b] If one analysis of 8,680 mg/kg is removed as an apparent outlier.

Note: This table was adapted from the Woodward-Clyde Consultants December 1990 Draft Stage 2 RI/FS Report.

volatile components of arctic diesel fuel represent approximately 30 percent (by weight) of the total mixture; 3) relatively cold temperatures and high soil moisture contents were noted during the study; 4) insufficient aromatic hydrocarbon detections were obtained during the initial site investigation (WCC 1990b). Leaching was also reportedly not an important loss mechanism because: 1) construction of a berm around landfarm reduced surface run-off potential; 2) a majority of organic components in diesel fuel are hydrophobic; 3) soils were subject to many years of precipitation and leaching prior to study (WCC 1990b).

The mean reduction in TPH concentrations observed in the disturbed tundra treatment area (SS11-Fuel Spill Site) is partially attributable to dilution resulting from the mixing of approximately 24 yd^3 of clean beach soil, which was added to reduce the soil moisture content (WCC 1990b). The mean reduction in TPH concentrations observed in native tundra (SS12-Spill No. 3 Site) must be viewed with caution due to the limited number of soil locations sampled and the uneven distribution of TPH across the tundra hill site (WCC 1990b). The degree to which natural degradation of diesel fuel contamination has occurred in native tundra has not been evaluated. However, the reported revegetation of the hillslope is a potential indication of TPH reduction (WCC 1990b). TPH concentrations identified in soil and groundwater samples from the STO5-Beach Tanks Site ranged from 70 to 21,000 mg/kg (soils) and 560 to 8,700 mg/L (groundwater). In addition to contaminant chemistry, conventional and biological characterization of groundwater adjacent to the beach tanks was conducted as part of the feasibility study. Table 1-7 presents maximum detected concentrations in STO5-Beach Tanks Site soil and groundwater samples.

Diesel fuel from surface storage tanks is the primary contaminant of concern at the STO5-Beach Tanks Site based on detections of TPH in soils and groundwater. Applicable or relevant and appropriate requirements (ARARs) were evaluated by WCC. Federal and State regulations that would potentially serve as ARARs were identified. Based on modified LUFT criteria, WCC recommended a TPH cleanup level of 1,000 mg/kg for beach soils. Chemical substances identified in soil and groundwater samples from the site include 2-methylnaphthalene, toluene, total xylenes, ethylbenzene, and TPH (see Table 1-7). A qualitative two-tiered risk screening methodology developed during the Stage 1 RI/FS was used to establish potential health and environmental risks at the site. The overall conclusion reported by WCC states that TPH at the beach tank site presents a potentially significant risk to aquatic organisms (WCC 1990b).

TABLE 1-7. 1989-1990 STAGE 2 RI/FS MAXIMUM DETECTED CONCENTRATIONS IN ST05-BEACH TANKS SITE SOIL AND GROUNDWATER SAMPLES		
Analytes	Soils (mg/kg)	Groundwater (mg/L)
TPH	21,000	8,700
Ethylbenzene	NA[a]	0.0063
Toluene	NA	0.034
Xylenes	NA	0.140
2-Methylnaphthalene	26	NA
Dissolved oxygen	NA	16
Chemical oxygen demand	NA	526
Biological oxygen demand	NA	81
Total dissolved solids	NA	1,250
Microbial Enumeration[b]		
Total bacteria	NA	5.73
Colony forming	NA	1.30
Fluorescent pseudomonad	NA	8.0
Phenaphthrene degraders	NA	1.03

[a] NA = Not analyzed.

[b] Total bacteria (x 10^7 per mL)
Colony forming units (x 10^7 per mL)
Fluoresent pseudomonads (x 10^1 per mL)
Phenaphthrene degraders (x 10^6 per mL).

A feasibility study (FS) was conducted by WCC for the ST05-Beach Tanks Site, identifying remedial technologies and evaluating technical applicability using site characteristics and data collected during the RI. Two operable units were developed for the beach area to provide appropriate remedial alternative evaluation. Remedial alternatives selectively screened and selected by operable unit for the ST05-Beach Tanks Site are presented in Table 1-4. An Interim Remedial Measure (IRM) was recommended by WCC for source control of fuel remaining in the beach tanks. The recommended IRM was to pump remaining fuels through a gravity water separator and use fuels locally as heating fuel. Fuel remaining in the tanks was removed, as were the beach tanks themselves, in 1992 (see Section 1.2.2.4).

Based on Stage 2 RI/FS results, the following sites were recommended for follow-on actions at Kotzebue LRRS (WCC 1990b):

- SS12-Spill No. 2 Site -- Continue the pilot study at the landfarm. Implement remedial actions at active pipelines, tanks, roadways, and the security fence.

- SS12-Spill No. 3 Site -- Continue the pilot study at the landfarm, and continue the *in situ* enhanced bioremediation pilot study on the tundra.

- SS11-Fuel Spill Site -- Continue the *in situ* enhanced bioremediation pilot study.

- ST05-Beach Tanks Site -- Mitigate soil and groundwater contamination using *in situ* bioremediation without groundwater capture.

Kotzebue LRRS Stage 2 RI/FS sites recommended for no further action included the SS01-Waste Accumulation Area No. 1, SS09-PCB Spill, and SS10-Solvent Spill Sites (WCC 1990b).

1.2.2.4 Beach Tanks Removal. Three diesel fuel storage tanks were formerly located approximately 0.25 miles southwest of the installation's Composite Facility, adjacent to Kotzebue Sound (see Figure 1-4). Two of the storage tanks were 50 ft in diameter and 22 ft high, each with a capacity of 7,890 barrels. The third storage tank measured 44 ft in diameter and 24 ft high, with a capacity of 6500 barrels (WCC 1990b). The estimate made during WCC RI/FS activities of the cumulative diesel fuel remaining in the three storage tanks was approximately 39,500 gal. In 1992, the Air Force removed the three diesel

fuel storage tanks from the site. Only the tank nests (bermed containment areas), asphalt tank pads within bermed areas, and the fuel pump house remain at the site.

1.2.2.5 ADEC Correspondence Regarding IRP Activities at Kotzebue LRRS. ADEC has provided letter correspondence to the Air Force regarding remedial activities conducted at Kotzebue LRRS. ADEC specifically provided comments concerning the Stage 1 Final No Further Action Decision and Final Technical Document to Support No Further Action for Five Sites on Kotzebue Air Force Station, July 1991, and the Stage 2 Installation Restoration Program Remedial Investigation/ Feasibility Study Report. A detailed list of ADEC correspondence, including specific issues, concerns, and recommendations are summarized in Table 1-8.

1.2.2.6 Environmental Baseline Survey (Navigational Aid Bldg. 101). In July 1993, Shannon and Wilson, Inc. conducted an environmental baseline survey of the Kotzebue LRRS Navigational Aid Building (Bldg. 101; see Figure 1-3). The environmental baseline survey was conducted for the University of Alaska, Fairbanks Facility Planning and Project Services Department as a requirement for a USAF long-term lease for this facility. The environmental baseline survey included the collection of eight building material samples for asbestos and four hand-augered soil samples for diesel range TPH analysis.

Asbestos building materials were identified in siding panels on the exterior walls and floor, and in the interior wall wainscoting (Shannon and Wilson, Inc. 1993). Analytical results for diesel-range TPH in soils is provided below.

Sample Identification	Sample Location	Diesel-Range TPH (mg/kg)
577-10	East side of above-ground storage tank north of building	4,200
577-11	East side of generator tank stand, south of building	700
577-12	8 feet east of above-ground storage tank, 7 feet north of building	180
577-13	In tundra approximately 110 feet north, and 25 feet west of west edge of building	70

TABLE 1-8. SUMMARY OF ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION CORRESPONDENCE REGARDING KOTZEBUE LRRS

Issue	Concern	Recommendation
November 1991:	**Stage 1 Final No Further Action Decision and Final Technical Document to Support No Further Action for Five Sites at Kotzebue Air Force Station, July 1991.**	
SS02-Waste Accumulation Area No. 2/ Landfill Site	WCC 1988 Stage 1 RI/FS reports that some wastes remaining at the landfill were buried. Site is near Kotzebue sound, a potential receptor.	Conduct record review to determine: - Types of wastes buried at the landfill. - Estimate quantity of wastes. - Determine how deep wastes are buried.
SS06-Spill/Leak No. 1 Site	ADEC concurred with no further action alternative for this site.	
SD03-Road Oiling Site	ADEC concurred with no further action alternative for this site.	
SS08-Barracks Pad Site	TPH concentrations of 5,960 ppm were reported at this site. TPH cleanup levels of 10,000 ppm for site soils was not acceptable to ADEC.	- Additional sampling to establish extent of diesel contamination with consideration of ADEC guidance for non-UST contaminated soils. - Determine current status of adjacent diesel fuel tanks.
SS07-Lake Site	3.4 mg/kg PCBs and 3.89 mg/kg total DDT metabolites detected in lake sediments. WCC 1988 State 1 RI/FS reports known spills appear to be in an assumed upgradient position.	- Establish source and extent of PCB and DDT detected in lake sediment samples.
December 1991:	**Stage 2 Final No Further Action Decision and Final Technical Document to Support No Further Action for Three Sites at Kotzebue Air Force Station, July 1991**	
SS01-Waste Accumulation Area No. 1	ADEC concurred with no further action alternative at this site.	
SS09-PCB Spill	ADEC concurred with no further action alternative at this site.	
SS10-Solvent Spill	ADEC concurred with no further action alternative at this site.	
January 1992:	**Installation Restoration Program Remedial Investigation/Feasibility Study Report, Stage 2, Kotzebue Air Force Base: Beach Tanks, Landfarm, SS12 Spills No. 2 and 3, and Fuel Spill Sites.**	
STO5-Beach Tanks Site	TPH concentrations of 21,000 mg/kg soil and 8,700 mg/kg groundwater detected at site. Estimated 13,900 gal cumulative diesel fuel remaining in beach tanks.	- Remove remaining fuel as an interim remedial measure. - Establish cleanup goals for soil and groundwater. - Evaluate potential free product on groundwater. - Bench-scale test conducted for groundwater.
Landfarm Site	Cover on landfarm reportedly torn and in poor condition. General condition of landfarm questionable. Seepage identified adjacent to landfarm.	- Report on the condition of the landfarm. - Provide specific design plans for the landfarm. - Begin landfarming activities earlier in the summer season to maximize remediation efficiency.
SS12-Spill No. 2 Site	Observed fuel seep appeared to originate at the Spill No. 2 site. Structures in the area restricted the removal of soils; diesel contamination remains at the site at unknown concentrations.	- Determine extent of contamination before proceeding with remedial action.
SS12-Spill No. 3 Site	Bioremediation effort appears to be progressing well.	- Continue bioremediation activities; monitor progress.
SS11-Fuel Spill Site	Bioremediation effort appears to be progressing well.	- Continue bioremediation activities; monitor progress.
May 1993:	**Kotzebue Long Range Radar Station**	
ST05-Beach Tanks Site SS12-Spill No. 2 Site SS12-Spill No. 3 Site SS07-Lake Site	Ongoing hazardous substance releases at Kotzebue LRRS represent potential violations of Alaska statutes and regulations. Kotzebue LRRS area may be presently used as recreational and subsistence activity area.	- Notify ADEC regarding remedial action work plans for Kotzebue LRRS.

Fuel was reportedly supplied to a generator and diesel furnace via above-grade steel pipelines connecting two small-capacity above-ground tanks. Spillage or overflow from the fuel delivery system reportedly resulted in soil contamination in the immediate vicinity of the tanks, and may be present at locations along the pipeline corridor (Shannon and Wilson, Inc. 1993).

1.2.2.7 1993 Site Survey. On 29 September 1993, Tetra Tech and Air Force personnel and their contractors conducted a site survey of Kotzebue LRRS and surrounding areas. The site survey was conducted to evaluate current site conditions, identify potential areas of concern, and obtain the information necessary to prepare RI/FS scoping documents in preparation for the 1994 IRP field activities. Based on the 1993 Site Survey, and discussions between Tetra Tech and Air Force personnel, ten areas of concern were identified for consideration in addition to the sites previously identified in the Stage 1 RI/FS Report (WCC 1990a). Identification and description of areas of concern is provided in Table 1-9. Figure 1-5 provides an installation diagram identifying the location of areas of concern.

The former landfill and waste accumulation area located adjacent to Kotzebue Sound were inspected during the site survey. The former landfill area exhibits intermittent areas of mounding that contain landfill debris, including metal wastes such as drums and other empty metal containers and metal debris. Additionally, two 12 volt batteries were identified mixed with metal debris at one mounded location. In the WCC Stage 1 RI/FS report (WCC 1990a), it was indicated that some former landfill wastes remained buried at the site. However, the site was excluded during the Stage 1 remedial investigation, and was recommended for no further action. The buried landfill wastes described by WCC are suspected to comprise the mounding observed during the 1993 Site Survey.

The landfarm located east of the Composite Facility was also inspected during the site survey. Based on visual inspection, the landfarm has not been properly maintained, with no cover to prevent infiltration or runoff and no limitations to site access. Landfarm soils were manually exposed during the site survey, revealing visual and olfactory indications of petroleum hydrocarbon contamination. Additionally, the formerly bermed margin of the landfarm was not discernable from the landfarm material proper. The landfarm has been included as an area of concern (see Table 1-9).

The SS12-Spills No. 2 and 3 Site was inspected during the site survey. In general, previous descriptions of this area reflect the observed site conditions, and include zones of stressed vegetation and petroleum

TABLE 1-9. 1993 SITE SURVEY AREAS OF CONCERN

Site Designation	Site Name	Site Description
AOC-1	Landfarm	During the Stage 2 RI/FS approximately 500 yd^3 of TPH contaminated soils were excavated from Spills No. 2 & 3 and Waste Accumulation Area No. 1 sites and stockpiled east of the access road, directly across from the Composite Facility. Landfarm activities were conducted to reduce TPH concentrations in affected soil throughout the Stage 2 RI/FS. During the 1993 site survey the landfarm was observed to be in poor condition, with no cover to reduce seasonal infiltration and runoff.
AOC-2	POL Line	Previous investigations at Kotzebue LRRS have not included assessment of the fuel line that transferred fuel from the POL (diesel) fuel tanks, formerly located on the beach, to the main facility.
AOC-3	East Tanks	Two above-ground diesel fuel storage tanks, with an estimated capacity of 20,000 gal each, are located on the east side of the access road adjacent to Building 205. The tanks are supported on concrete footings set in a gravel pad, and are contained within a bermed area. The tanks and surrounding area have not been previously assessed, and some limited signs of soil staining directly beneath outlet valves was observed during the 1993 site survey.
AOC-4	Garage/ Power Plant	Stained soils were observed beneath the raised flooring (approx. 4 ft above ground surface) of the power plant and garage area associated with the Composite Facility. It has not been established that floor drains within these areas discharged directly to the ground.
AOC-5	Small Day Tanks	A number of small day tanks (250 gal above ground diesel fuel tanks) were formerly used throughout the installation. Potential diesel fuel releases could have occurred historically due to overfilling or direct release from tanks or tank lines. No previous assessment of these smaller tanks (as a group) has been conducted.
AOC-6	Navigational Aid Bldg. (101-200)	The navigational aid building is located north of the Composite Facility. The navigation aid building and an adjacent associated structure have been included for assessment based on elevated TPH concentrations in soils identified during a 1993 Environmental baseline survey conducted at Building 101. During the 1993 site survey the buildings were locked and not accessible. The surrounding area did not indicate obvious signs of contamination.
AOC-7	Steel Pilings	This site is identified by steel structure pilings (I-Beams) located east of Building 205, on the east side of the installation's access road. Buildings identified during review of historical aerial photographs suggest that this area was a former construction camp site established during initial radar facility construction.
AOC-8	White Alice Garage	The White Alice garage was reportedly used for storing and servicing site vehicles; no identified releases or hazardous materials storage information has been reported. However, this area has not been previously characterized, and has been recommended for assessment based on past usage of the building. During the 1993 site inspection the building was not accessable for interior inspection. Based on visual observations reported, no obvious signs of contamination were identified.
AOC-9	White Alice Tanks	Two diesel fuel storage tanks, with an estimated capacity of 20,000 gal each, are located at the White Alice Station adjacent to Building 1001. The tanks are presently empty, and tank piping has been disconnected. The tanks are contained within a bermed area and are supported above a gravel base by concrete footings. The tanks are a new area of concern based on reports regarding observed overfilling at outlet valves during previous 11th CEOS site visits. The 1993 site survey revealed some signs of soil staining directly beneath outlet valves, and an open drum under one of the tank valves was half filled with water, and is assumed to have been used to contain fuel spillage during piping disconnection. The tanks appear to be in good condition, with no observable signs of deterioration.
AOC-10	Septic Holding Tank	The primary sewage treatment of domestic wastewater was provided by a single septic tank located west of the composite facility. Septic tank effluent was discharged into Kotzebue Sound through an outfall line. Shop floor drain wastewater was reportedly discharged to septic tank.

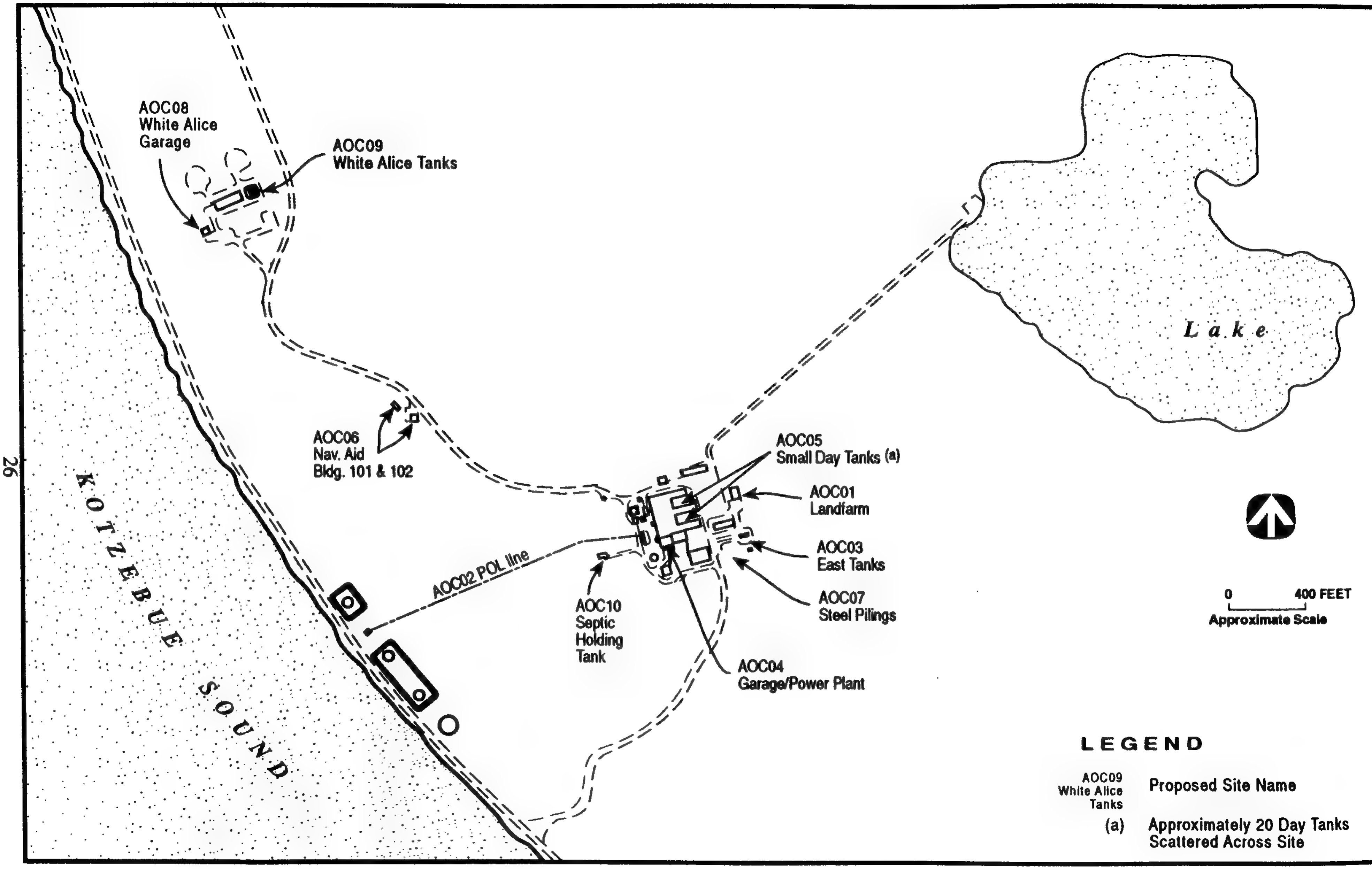


Figure 1-5. Areas of Concern (AOCS) Identified During 1993 Site Reconnaisance, Kotzebue LRRS Alaska.

hydrocarbon seepage from a small area of sloping gravel fill material. During previous IRP investigations, the excavation of soils was conducted to remove source materials. However, the specific excavation zones were not discernable, possibly due to regrading activities.

1.2.2.8 Current Site Status. Twelve sites have been identified at Kotzebue LRRS during previous IRP investigations (see Table 1-1). Spills No. 2 and 3 were originally identified as separate sites during the 1985 Phase I Records Search. However, due to the similar nature of contamination (diesel fuel), and the fact Spill No. 2 has commingled with Spill No. 3, these sites have been combined (Site SS12-Spills No. 2 and 3) for a total of 11 identified sites at Kotzebue LRRS.

The USAF has recommended the no further action alternative at eight of the 11 sites at Kotzebue LRRS based on the results of past remedial investigations and remedial actions. ADEC has documented concurrence with the no further action alternative for five of the eight recommended sites, including Sites SS06-Spill/Leak No. 1, SD03-Road Oiling, SS01-Waste Accumulation Area No. 1, SS09-PCB Spill, and SS10-Solvent Spill (see Table 1-8).

During the September, 1993 site survey, ten areas of concern were identified by Tetra Tech and Air Force personnel that warrant further consideration as potential sites during the 1994 RI/FS field sampling effort (see Table 1-9). Figure 1-6 identifies the 11 sites at Kotzebue LRRS, including those sites considered closed by USAF and ADEC, and the locations of areas of concern (AOCs) to be investigated in 1994.

1.2.3 Existing Remedial Actions

Remedial actions conducted at Kotzebue LRRS during previous IRP investigations are described in Section 1.2.2, Previous Investigation Activities and Documentation. No remedial actions have been conducted at Kotzebue LRRS since WCC Stage 2 RI/FS activities concluded at the end of the 1990 field season. In 1992, the Air Force conducted an interim remedial action, removing the three large fuel tanks located adjacent to Kotzebue Sound. The landfarm constructed east of the Composite Facility contains approximately 550 yd^3 of soils and fill treated during previous IRP remedial actions. The current nature of landfarm soils is not known, and the present condition of the landfarm cell is questionable.

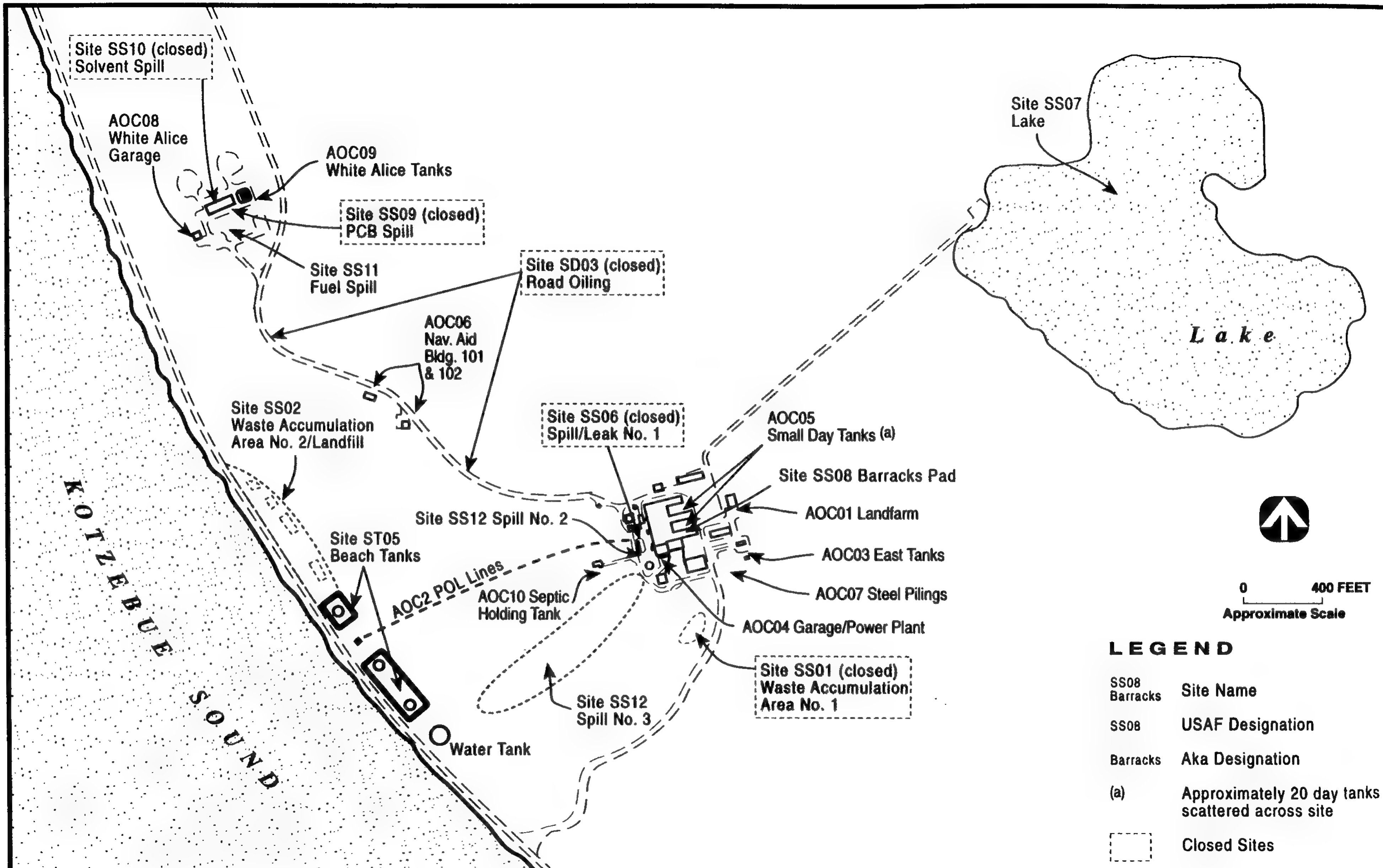


Figure 1-6. Current Site Summary, Kotzebue LRRS, Alaska.

1.3 DESCRIPTION OF CURRENT STUDY

The RI/FS process includes a scoping task to define data requirements and objectives, a remedial investigation to characterize sites and support a baseline risk assessment, and a feasibility study to define and evaluate available remedial alternatives to support the selection of specific remedial actions. The RI/FS process can be conducted in stages that focus on particular aspects of each process. A Stage 1 and Stage 2 IRP RI/FS have been previously conducted at Kotzebue LRRS as described in Section 1.2.2, Previous Investigation Activities and Documentation. However, remaining concerns regarding current site conditions necessitate further site investigation and remedial response in order to achieve environmental restoration at Kotzebue LRRS. This section describes general project objectives, reviews scoping document preparation in support of remedial investigation/feasibility study tasks, and identifies subcontractors and their roles during the proposed IRP RI/FS activities.

1.3.1 Project Objectives

Tetra Tech's general approach regarding the development of the Kotzebue IRP RI/FS is to maximize the use of existing data from previous investigations. Available site information has been integrated into the Kotzebue LRRS site conceptual model, and has been used to identify additional data needs, facilitate the selection of remedial designs, and to guide the risk assessment process. Overall project objectives for the Kotzebue LRRS RI/FS include:

- Provide data of sufficient quality and quantity to adequately characterize sites in support of a natural biodegradation evaluation, baseline risk assessment, applicable or relevant and appropriate requirements (ARARs), and a feasibility study.

- Conduct a feasibility study designed to enable the USAF to focus on appropriate remedial actions with consideration to logistical, environmental condition, and climatic limitations.

- Provide appropriate project information and opportunities for community involvement in order to develop a positive relationship between the USAF and the community of Kotzebue, Alaska.

1.3.2 Scoping Documents

The RI/FS process includes scoping to define data requirements and objectives. The purpose of the project scoping documents is to clearly and comprehensively define project objectives and activities prior to the initiation of field work. Scoping documents prepared in support of the Kotzebue LRRS IRP RI/FS are identified and described as follows:

- Engineering Network Analysis (ENA)--The ENA (or Gannt chart) is a detailed task plan for the projected RI/FS work effort. The ENA is prepared in the form of a progress chart that indicates the percentage of work scheduled for completion by any given date during the period of the delivery order. The ENA is updated and submitted quarterly.

- Work Plan (WP)--The purpose of the WP is to describe the work to be performed, explain project objectives, and present the rationale for conducting specific project activities. Due to the extreme remoteness of Kotzebue LRRS, the WP will include a detailed scheduling plan integrating the logistics and strategy necessary to complete the RI/FS field activities during the 1994 field season.

- Sampling and Analysis Plan (SAP)--The SAP includes both a Quality Assurance Project Plan (QAPP) and a Field Sampling Plan (FSP) describing how field activities will be accomplished.

- Community Relations Plan (CRP)--The CRP is a comprehensive document that will include a description of Kotzebue LRRS and the community of Kotzebue, Alaska, identify previous IRP activities and sites, provide an overview of community involvement to date, describe community concerns regarding the site and USAF site activities, and suggest community involvement during future IRP activities.

All scoping documents in support of the Kotzebue LRRS RI/FS have been prepared in accordance with the IRP Handbook.

1.3.3 Identification of Subcontractors and Their Roles

Drilling and analytical laboratory subcontractor services will be required in support of IRP RI/FS activities to be conducted at Kotzebue LRRS. Site surveying activities will be conducted by USAF personnel not under subcontract to Tetra Tech. The following Tetra Tech subcontractors will provide services for work accomplished under the IRP RI/FS at Kotzebue LRRS:

<u>Analytical Laboratory</u>

Prime Source:

Analytical Resources, Inc.
333 9th Avenue, North
Seattle, WA 98109
Telephone (206) 621-6490
Facsimile (206) 621-7523

Auxiliary Source;

Pace Laboratories, Inc.
1710 Douglas Drive North
Minneapolis, MN 55422
Telephone (612) 544-5543

<u>Drilling Services</u>

Beck Environmental Contracting
1310 W. International Airport Road
Anchorage, Alaska 99518
Telephone (907) 563-1121
Facsimile (907) 563-2755

2.0 INFORMATION SUMMARY FOR KOTZEBUE LRRS

This section summarizes information from previous IRP reports and other available references, and includes a discussion regarding the environmental setting at Kotzebue LRRS, remedial actions implemented at the facility, applicable or relevant and appropriate requirements (ARARs), and project data needs.

2.1 ENVIRONMENTAL SETTING

The two distinct environmental settings associated with the Kotzebue LRRS study area are the beach environment adjacent to Kotzebue Sound and the tundra hill and surrounding area. The following sections describe the environmental settings associated with Kotzebue LRRS, provide a summary of site-specific geologic/hydrogeologic data collected during previous IRP investigations, and discuss area demographics and land use.

2.1.1 Physiography

Kotzebue LRRS is located on the Baldwin Peninsula, a marine spit that extends into Kotzebue Sound. The Baldwin Peninsula lies within the Kobuk-Selawik Lowland section of Coastal Western Alaska (see Figure 1-2). This physiographic area is characterized by broad river flood plains and lowlands, forming deltas along their seaward margins. The ground surface is composed of moist tundra vegetation, with wet silts and permafrost underlying most of the area (WCC 1990a). Figure 2-1 is a reproduction of a 1986 aerial photograph of Kotzebue LRRS showing general site features. Figure 2-2 is a reproduction of a 1974 aerial photograph of the Kotzebue area, showing the town of Kotzebue in relation to the site.

The maximum topographic relief at Kotzebue LRRS is from Kotzebue Sound to the crest of the tundra hill at the Composite Facility, approximately 155 feet. Flooding is not known to have been a problem in the study area, although the U.S. Army Corps of Engineers indicates that the site is located in a coastal

Figure 2-1. 1984 Aerial Photograph of Kotzebue LRRS (reproduction).

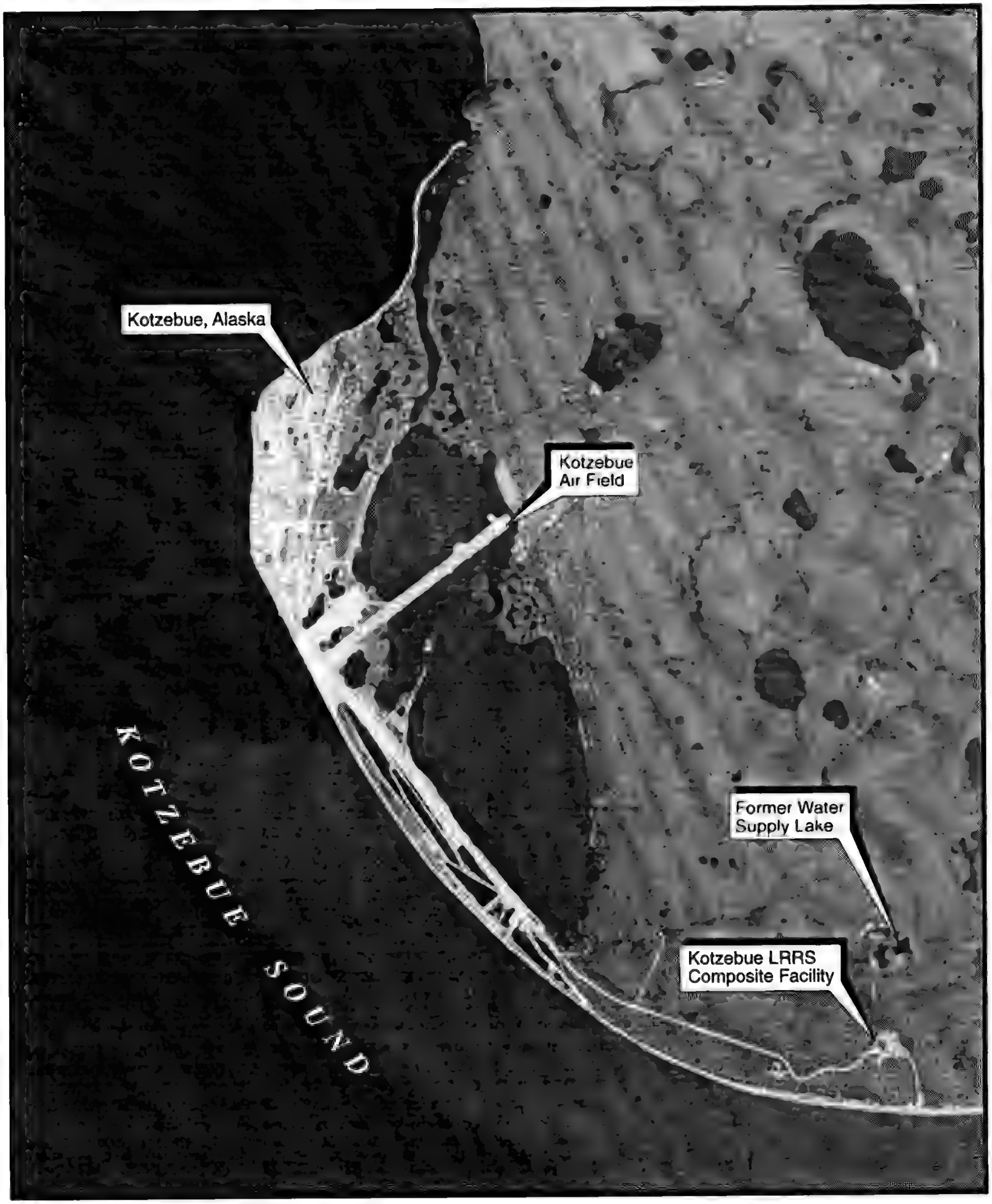


Figure 2-2. 1980 Aerial Photograph of Kotzebue, Alaska (reproduction).

flood hazard zone as designated by the Federal Insurance Administration (WCC 1990a). Periodic flooding of local beaches and adjacent low-lying areas occurs when high tides and high shoreward winds coincide. However, with the exception of the STO5-Beach Tanks and SS02-Waste Accumulation Area No. 2/Landfill Sites, all sites at Kotzebue LRRS are located topographically above anticipated flood zones, at elevations ranging from 120 to 155 ft above mean sea level (MSL).

2.1.2 Climate

Kotzebue LRRS is located 26 miles north of the Arctic Circle on the coast of Kotzebue Sound in northwest Alaska, and lies in the maritime climate zone. Annual temperatures range from an average maximum of 27^{o} F (mean maximum high of 59^{o} F in July) to an average minimum of 14^{o} F (mean minimum low of -13^{o}F in January). The mean annual rainfall is 7.1 inches, and the mean annual snowfall is 43 inches, for a total average annual precipitation of approximately 12 inches (WCC 1990a). The maximum 2-year, 24-hour precipitation is 1.8 inches (ES 1985). No evapotranspiration data are reported for the area. The prevailing wind direction is out of the east-southeast at an average speed of 11 knots.

2.1.3 Geology

The Baldwin Peninsula is composed of Quaternary glacial deposits exceeding 150 ft in thickness. Beaches here are composed of sands and gravels, and the relatively straight shorelines are backed by wavecut terraces that form moderately steep sea cliffs in the unconsolidated glacial sediments (Hayes and Ruby 1979). The Kotzebue LRRS study area is dominated by glacial moraine and drift deposits, which are overlain locally by a thin sandy beach deposit. The moraine and drift deposits are comprised of clays, silts, sands, and gravels; their total thickness is not known (WCC 1990a).

Permafrost has been identified during previous IRP investigations at Kotzebue LRRS at relatively shallow depths ranging from less than 1.0 ft to a maximum of 6.0 ft below ground surface (BGS) at sites located on the tundra hill above of the Kotzebue Sound beach area. Permafrost was not encountered along Kotzebue Sound beach and back shore areas during previous IRP investigations (maximum depth investigated = 10 ft BGS). Permafrost is moderately thick in the Kotzebue area, and has been reported to a depth of 238 ft below grade. The permafrost is underlain by fine-grained sediments containing brackish subpermafrost water (Williams 1970; WCC 1990a).

2.1.4 Groundwater

Groundwater occurs regionally beneath the moderately thick permafrost layer, termed subpermafrost water. Recharge and discharge of subpermafrost groundwater is limited to unfrozen zones that breach the overlying permafrost. Additionally, a very shallow system exists locally above permafrost, termed suprapermafrost water. The near-surface and surface water system in which suprapermafrost water occurs is termed the active zone when seasonal temperatures are sufficient to support melting in this zone, which typically coincides with the break-up and summer. Active zone water associated with the tundra hill sites at Kotzebue LRRS occurs intermittently (seasonally) and is not characterized by a continuous zone of saturation, but is seasonally present as thin, discontinuous, and isolated zones of suprapermafrost water. In this environment, active zone water is considered surface water by ADEC. Active zone water associated with the tundra hill sites at Kotzebue LRRS may represent a seasonal surface water source.

Active zone water is transitional into an unconfined aquifer system along the beach at Kotzebue Sound, where the depth to permafrost is sufficient to support a continuously saturated subsurface zone of groundwater. The thickness of the unconfined aquifer system immediately adjacent to Kotzebue Sound is not known, but water levels are tidally influenced, and the aquifer is brackish to saline. The depth to permafrost in the beach area is not known, but permafrost is encountered at shallow depths a short distance from the beach in the sea cliffs. Permafrost likely does not extend more than a short distance beneath Kotzebue Sound.

Permafrost is impermeable to groundwater flow because pore spaces that would normally be available for the transport of groundwater are ice filled. Surface water bodies such as lakes, ponds, streams, and rivers typically depress the upper surface of permafrost, changing the thickness and configuration of permafrost beneath the water body. Permafrost may be entirely absent beneath large water bodies. Because permafrost acts as an impermeable barrier to infiltration and aquifer recharge, surface water runoff is greatly increased in permafrost environments, enhancing the formation of lakes and wetlands.

2.1.4.1 Subpermafrost Water. Permafrost is moderately thick in the Kotzebue area, and has been reported to a depth of 238 ft below grade. The permafrost is underlain by fine-grained sediments containing brackish subpermafrost groundwater; increasing salinity with depth has been reported (Williams 1970; WCC 1990a).

The salinity of subpermafrost groundwater in the Kotzebue area has prompted the development of surface water sources to satisfy local water supply requirements (WCC 1990a). The relatively thick permafrost layer beneath the Kotzebue LRRS study area acts as a confining layer between suprapermafrost surface water and subpermafrost groundwater regimes, inhibiting potential percolation and recharge of the subpermafrost groundwater system.

2.1.4.2 Suprapermafrost Water (Active Zone). The occurrence of active zone water at Kotzebue LRRS has been previously described for two distinct environments, including the tundra hill and surrounding area, and the Kotzebue Sound beach area. The tundra hill and surrounding area generally has near-surface silts that extend down to the shallow permafrost. Recharge of the active zone is limited by the low average annual precipitation and fine-grained nature of shallow soils, mentioned previously. Flow is assumed to be relatively slow because of the low intrinsic permeability of the silty soils, and transport is likely limited by seasonal soil freezing in most areas. The occurrence of active zone water at sites associated with the tundra hill is highly variable and locally discontinuous according to information gather during previous IRP investigations.

The Kotzebue Sound beach area is comprised of coarse sands and gravels; permafrost has not been observed at or above the maximum depth investigated (10 ft BGS). Shallow groundwater was detected at approximately 3.0 ft BGS along the beach face adjacent to Kotzebue Sound, and at 7.0 ft BGS adjacent to beach fuel tank during a previous IRP investigation. Shallow groundwater along the beach likely flows toward Kotzebue Sound at relatively high rates because of the high intrinsic permeability of the beach sands and gravels. Previous characterization of the near-beach groundwater system associated with the ST05-Beach Tanks Site indicates that the groundwater is saline (brackish) in nature, is tidally influenced, and represents a non-potable resource.

The seasonally intermittent nature of suprapermafrost water occurrence, and the salinity of subpermafrost groundwater in the Kotzebue area has prompted the development of surface water sources to satisfy local water supply requirements. However, some domestic consumers in Kotzebue may employ shallow wells screened in spit gravels to obtain suprapermafrost water from a zone ranging between 4 and 20 feet in thickness, although it is very unlikely that this would provide a dependable supply of water because the

active zone is frozen for approximately 8 months of each year (WCC 1990a). The domestic wells closest to the installation are all located in the City of Kotzebue, 4 miles away. There are no known uses of surface water or groundwater located within a 3-mile radius of Kotzebue LRRS.

2.1.5 Surface Water

The surface waters of Alaska are classified in accordance with both their present and their potential utilization to maintain the highest quality standards possible. The classification system distinguishes between inland and marine waters, and further subdivides these broad categories. The classification system is detailed in <u>Water Quality Standards</u> (Alaska Department of Environmental Conservation 1979). All of the fresh water streams in the Kotzebue LRRS area are classified as a IA Water Supply. Kotzebue Sound is classified as a IIA Water Supply (aquaculture, seafood processing, etc.; WCC 1990a).

2.1.5.1 Surface Water Occurrence. Surface waters associated with Kotzebue LRRS and the surrounding area include Kotzebue Sound, small lakes and ponds, wetlands, bogs, thermokarsts, and small streams (see Figure 2-2). Lake and pond waters are characteristically a brown color due to naturally occurring tannins in the water draining the adjacent tundra (WCC 1990a). Surface water bodies within a one mile radius of the installation include the following:

- June Creek--June Creek is located approximately 1.0 miles north of the Composite Facility and flows to the northwest into the large lagoon (brackish) adjacent to Kotzebue Sound. Two small unnamed tributaries of June Creek have been mapped approximately 0.25 miles north and 0.25 miles east-northeast (former LRRS water supply lake outlet) of the Composite Facility (USGS Topographic Map, Kotzebue D2 Quadrangle 1951, Revised 1988). It is suspected that these small tributaries are only active during a relative short period of time in the spring during snow melt (break-up). Aerial photographs taken over several years indicate that these small tributaries do not provide active flow during late the spring and summer months.

- LRRS Former Water Supply Lake--The former Kotzebue LRRS water supply lake is located approximately 0.25 miles east-northeast of the Composite Facility at an approximate elevation of 37 ft MSL. The lake is approximately 1000 ft in length and

600 ft wide. However, during the mid and late summer months, the lake's volume is significantly reduced. The total depth of the lake has not been determined, but aerial photographs indicate that the lake is relatively shallow.

- Wetlands--Wetlands are located approximately 0.25 miles east of the Composite Facility adjacent to and surrounding the former water supply lake.

- Kotzebue Sound--Kotzebue Sound is located approximately 0.25 miles west of the Composite Facility. The Composite Facility is located at an approximate elevation of 155 ft MSL.

- Installation Surface Water Features--Intermittent ponding has been reported southwest of the Composite Facility along the moderately sloping hillside above Kotzebue Sound. The ponded water observed at the installation is a result of rainfall and snow melt, and is most pronounced in late spring/early summer as a result of break-up.

2.1.5.2 Installation Surface Water Drainage. Kotzebue LRRS is situated on top of a tundra hill located approximately 0.25 miles east of Kotzebue Sound. Most of the sites at Kotzebue LRRS range in elevation from 120 ft to 155 ft MSL. Surface water runoff originating from Kotzebue LRRS is topographically directed either west toward Kotzebue Sound, or east toward the adjacent wetlands. Runoff draining east could potentially reach the former water supply lake. Table 2-1 presents surface water drainage features and directions for sites located at Kotzebue LRRS.

Melting of the annual snowpack usually occurs over a relatively short time period each year, referred to as break-up, and coincides with the greatest annual surface flow at Kotzebue LRRS. The average break-up and freeze-up dates for the Kotzebue area are 17 May to 8 June and 2 October to 5 November, respectively (Schroeder et al. 1987). Soils remain frozen during much of break-up, and the potential for contaminant migration via the surface water pathway is suspected to be low (WCC 1990a). Surface water infiltration rates have not been published for Kotzebue, but recharge to the tundra hill active zone is limited by the low average annual precipitation, extended periods of sub-freezing conditions, and low permeability of native soils.

2.1.5.3 Surface Water Drinking Supply. Historically, the installation used a small lake as a water supply (see Figure 1-2). However, use of the water supply lake was discontinued in 1985 when the installation became a minimally attended radar system. Drinking water at Kotzebue LRRS is currently obtained from the City of Kotzebue. The City of Kotzebue uses Devil's and Vortac Lakes, located near the town, as municipal water supply sources (WCC 1990a).

2.1.6 Site-Specific Geologic/Hydrogeologic Data

Geologic and hydrogeologic information obtained during previous IRP investigations at Kotzebue LRRS are summarized and presented in Table 2-1. Table 2-1 does not provide a comprehensive summary of all available site-specific data, but presents values for geologic and hydrogeologic characteristics affecting contaminant fate and transport at Kotzebue LRRS sites.

2.1.7 Biology

Natural resources associated with the Kotzebue LRRS and surrounding area are limited by severe climate, short growing seasons, and poor soil conditions associated with permafrost and tundra environments. The following sections provide a general description of native vegetation, fish and wildlife, and threatened or endangered species associated with the Kotzebue area.

2.1.7.1 Vegetation. Moist tundra vegetation surrounds Kotzebue LRRS. Cottongrass tussocks and dwarf shrubs completely covers the ground in most areas. Soils are commonly saturated, and mosses and lichens grow in channels between tussocks (USAF 1993). Frost action creates small frost polygons supporting grass and forbs in many areas. Commonly occurring plants at Kotzebue LRRS include dwarf birch, labrador tea, mountain avens, bistort, and saxifrages. The moist tundra in the Kotzebue area is very sensitive to damage, and the natural revegetation and recovery of disturbed plant communities can take many years or decades (USAF 1993).

2.1.7.2 Fish. A variety of fish inhabit the inland and coastal waters of the Kotzebue area. All five species of Pacific salmon are found in Kotzebue Sound, but only chum salmon occur in substantial numbers (Kessler 1985). Other anadromous species important to subsistence fishing in the area include whitefish, nine-spined stickleback, and arctic char (Kessler 1985). Marine species found in the area include tomcod, Arctic cod, rainbow smelt, flounder, and herring (Kessler 1985; USDA 1979). Important freshwater species include grayling, pike, and sheefish (USAF 1993).

TABLE 2-1. HYDROGEOLOGIC CHARACTERISTICS SUMMARY FOR KOTZEBUE LRRS SITES[a]

Site Identification	Depth to Permafrost (ft BGS)[b]	Depth to Suprapermafrost Water (ft BGS)	Estimated Subsurface Flow Direction	Estimated[c] Subsurface Flow Rate (ft/yr)	Estimated Hydraulic Gradient	Surface Drainage Feature	Surface Drainage Direction	Soil Profile[d]	
								Depth (ft BGS)	Description
SS01-Waste Accumulation Area No. 1	2.8 to 6.3	Not encountered	South	0.2	0.1	Poor drainage Steep slope locally	South/ Southwest	0.0 to 2.3 2.3 to 3.0 3.0 to 4.8	Medium sand with gravel (fill) Tundra mat Brown silt
SS12-Spill No. 2	5.0 to 5.2	2.0 to 4.0	Southwest	0.01	0.05	Poor drainage Slight slope	Southwest	0.0 to 2.0 2.0 to 2.5 2.5 to 5.0	Gravelly sand (fill) Tundra mat Gray silt
SS12-Spill No. 3	<1.0 near site >10 base of slope	<1.0 near site >10 base of slope	Southwest	0.02	0.07	Poor drainage Steep slope in tundra	Southwest	Three individual lithologes See Figure 18.	
SS07-Lake	ND[e]	ND	Assumed North	ND	ND	Fair to poor drainage	North	ND	ND
SS08-Barracks Pad	3.0 to 4.0	Not encountered to 1.6	ND	<0.1	ND	Poor drainage Very slight slope	East	0.0 to 2.4 2.4 to 2.6 2.6 to 3.5	Gravel, coarse sand (fill) Tundra mat Gray silt
SS09-PCB Spill	>1.0	Not encountered	ND	ND	ND	Poor drainage Slight slope	Variable	Sand and gravel (fill) pad overlying tundra mat and silt	
SS10-Solvent Spill	>2.5	Not encountered	ND	<0.1	ND	Poor drainage Slight slope	North	0.0 to 2.5, fine to coarse sand (fill) 2.5 to 2.7, grey silt	
SS11-Fuel Spill	1.4 to 2.2	Not encountered	East	0.01	0.06	Poor drainage Slight slope	East	0.0 to 1.0 1.0 to 2.0	Tundra mat Brown silt
ST05-Beach Tanks	>8.0	3.0 adjacent to sound 7.0 at tank pads	Southwest	1,180	ND	Good drainage	Southwest	Gravelly fine to coarse sand with interbedded coarse gravel layers	

[a] Hydrogeologic characterstics were compiled from Stage 1 and 2 RI/FS reports.
[b] (ft BGS) = Feet below ground surface.
[c] Subsurface water flow rates are estimates, which may vary by orders of magnitude.
[d] Soil profiles are described from ground surface to top of permafrost or total depth of boring.
[e] ND = Not determined.

2.1.7.3 ***Terrestrial Mammals.*** Terrestrial mammals inhabiting moist tundra habitats include several species of vole, tundra shrew, lemming, tundra hare, Arctic ground squirrel, caribou, and red fox. Larger species such as brown and grizzly bear, wolf and moose also inhabit this environment, but do not typically range onto the Baldwin Peninsula (USAF 1993).

2.1.7.4 ***Marine Mammals.*** Whales such as bowhead, gray, killer, and beluga, in the Kotzebue area. Several seal species also inhabit the area and are harvested by the local native community, as are walrus (USAF 1993).

2.1.7.5 ***Birds.*** The moist tundra environment is an important foraging area for many birds during the summer, when migrating species visit the region. The area also provides breeding and foraging habitat for waterfowl and shorebirds. The most common seabird species, found in the area include the long-tailed jaeger, common murre, arctic tern, and glaucous gull (USAF 1993).

2.1.7.6 ***Threatened or Endangered Species.*** No threatened or endangered species are known to occur at Kotzebue LRRS. However, peregrine falcons have been noted along the major drainages in the region, and thus may occasionally range onto the installation (USAF 1993).

2.1.8 Demographics

Kotzebue LRRS is operated as a minimally attended radar installation. A radar maintenance technician is reportedly present at the station 24 hours a day. Radar maintenance technicians are housed in the nearby City of Kotzebue.

Kotzebue, Alaska has an estimated population of 3,649 people based on 1991 federal census results. The community of Kotzebue serves as a regional service and distribution center for the Northwest Arctic Borough, an area of 37,300 square miles incorporating 11 villages: Kotzebue, Ambler, Buckland, Deering, Kiana, Kivalina, Kobuk, Noatak, Noorvik, Selawik, and Shungnak. The population distribution within the Northwest Arctic Borough includes 55 percent residing in the 10 smaller communities, with the remaining 45 percent in Kotzebue. Kotzebue is a predominantly Inupiat community, with Alaska Natives comprising 75 percent of its population according to U.S. Census data (Fall et al. 1993). Historically, Kotzebue has grown as a transportation hub for river travel along the Noatak, Kobuk, and Selawik Rivers, as well as for air travel to northern Alaska. Kotzebue's position as a modern regional center

emerged after World War II, largely owing to the establishment of government facilities and services there. Much of Kotzebue's population growth has resulted from in-migration from surrounding villages (Fall et al. 1993).

The Kotzebue economy is sustained by the regional offices and facilities of the many state and federal agencies that serve northwest Alaska and are located in Kotzebue (WCC 1990a). The top source of income is from jobs relating to federal, state and local governments, including jobs associated with schools. Employment by industry indicates that most jobs were in services (25 percent), commercial fishing (14 percent), education (13 percent), and retail trade (11 percent; Fall et al. 1993).

It is estimated that greater than 70 percent of Kotzebue's population engages in subsistence activities, including an estimated 69 percent processing wild resources (e.g., cleaning and preparation of wild game, drying fish, canning, etc.), 36 percent hunting, 53 percent fishing, 3 percent trapping, and 61 percent gathering wild plants (Fall et al. 1993). The total subsistence harvest by resource is comprised of land mammals (especially caribou and moose) at 31 percent, fish other than salmon (e.g., sheefish) at 27 percent, marine mammals (e.g., bearded seals) at 26.8 percent, and salmon (primarily chum salmon) at 13 percent (Fall et al. 1993).

2.1.9 Land Use

Currently, Kotzebue LRRS is used solely as a minimally attended radar facility (MAR), with no active housing facilities or military presence. Martin Marietta Services is responsible for maintenance of real property facilities, which includes the MAR, abandoned buildings, roads, grounds, and antenna structures. The active portion of the installation, including the MAR and nearby structures, is completely fenced and secure. Abandoned housing facilities and other structures surrounding the MAR are closed to the public, but are located outside the fenced area (USAF 1993).

The property occupied by Kotzebue LRRS is not used by other private or governmental agencies. However, the area does provide suitable habitat for a wide variety of wildlife, and subsistence and recreational use may occur within or near installation boundaries. Subsistence use may include berry picking in adjacent tundra wetlands, terrestrial hunting along the tundra hill and surrounding area, and marine hunting and fishing along the Kotzebue Sound beach area. Recreational uses may include ATV use along roads and beach areas, summer picnicking and wading along beach areas, beach combing, and

recreational hunting and fishing. Additionally, the beach area near Kotzebue LRRS has been reportedly used as a staging area for commercial fishing of chum salmon and as a rifle range used by local residents (USAF 1993).

Kotzebue LRRS is anticipated to maintain MAR operations at current (or possibly reduced) levels over the next few years. Remedial actions at IRP sites and demolition of abandoned structures are future activities anticipated at the installation. Future demand of fisheries and wildlife are primarily linked to native subsistence use, with resource management in the area under the jurisdiction of the Alaska Department of Fish and Game. Future outdoor recreation activities at Kotzebue LRRS and surrounding area are anticipated to be consistent with current recreational use associated with the area (USAF 1993). Future land use issues and strategies associated with Kotzebue, Alaska and surrounding areas have been considered by the Northwest Arctic Borough (NAB) and presented in the NAB Comprehensive Plan (NAB 1992).

2.2 SITE CONCEPTUAL MODEL

The primary purpose of the site conceptual model is to integrate available site information, identify additional data needs, facilitate the selection of remedial designs, and guide the risk assessment process. The Kotzebue LRRS site conceptual model has been based almost exclusively on a review of information collected during past IRP investigations. The assumptions used in constructing the conceptual model, and the resulting limitations of the model, are based on the quality and utility of the data and information collected during past IRP investigations.

2.2.1 Establishment of Background Concentrations and Site Contaminant Identification

No background concentrations for soil, surface water, or groundwater were identified during a review of documents generated from previous IRP investigations conducted at Kotzebue LRRS. WCC (1990a) states that metals concentrations detected in site soils are within the normal range found in the contiguous United States, and that the concentration of inorganic chemical constituents presented in the Final Environmental Impact Statement for Cape Krusenstern, Alaska, suggests that metals concentrations in

Kotzebue LRRS soils are typical of native soil background concentrations for this area. However, literature values of typical concentrations are not a generally accepted substitute for site-specific background concentrations.

Organic compounds detected in soils during previous IRP investigations at Kotzebue LRRS include TPH (by Method 418.1), PCBs (Aroclor 1260), pesticides (4,4'-DDD), 4,4'-DDE, 4,4'-DDT, and Delta-BHC), and benzene, ethylbenzene, toluene, and total xylenes (BETX). Organic compounds previously detected in near-beach groundwater at Site ST05-Beach Tanks include TPH (by Method 418.1), ethylbenzene, toluene, total xylene, and 2-methylnaphthalene. Pesticides and PCBs were not analyzed for in samples collected at the ST05-Beach Tanks Site. No organic compounds were detected in surface waters sampled during the previous IRP investigation. Pesticides and PCBs were detected in lake sediment samples from Site SS07-Lake. The maximum concentrations of organic compounds and metals detected in soil, surface water, and groundwater samples collected at Kotzebue LRRS are presented in Tables 1-3 and 1-7.

Petroleum hydrocarbon contamination linked to past installation operations and activities is the primary environmental problem identified at Kotzebue LRRS. Arctic-grade diesel and jet fuel are the suspected sources of detected concentrations of TPH and BETX in site soils and groundwater. Diesel and jet fuel are middle distillates of crude oil, with diesel fuel containing about 8 percent n-alkanes, 22 percent iso-alkanes, 31 percent cycloparaffins, and 38 percent aromatic compounds that contain approximately 10 percent BETX and 10 percent polynuclear aromatic hydrocarbons (PNAs). Diesel blended for arctic use generally contains more low molecular weight hydrocarbons than does normal diesel fuel (WCC 1990a). Aromatic hydrocarbons (such as BETX) were detected at relatively low concentrations in a limited number of soil and groundwater samples collected at Kotzebue LRRS (see Tables 1-3 and 1-7). The single detection of benzene was in a sample of soil from the SS12-Spill No. 3 Site at a concentration of 0.86 mg/kg (see Table 1-3). The limited detections of aromatic hydrocarbons in Kotzebue LRRS soils likely results from the low percentage of these compounds in fuels used at the site, and from volatilization and biodegradation that has occurred since the time of release.

Remedial actions conducted during previous Kotzebue LRRS IRP activities, include landfarming and *in situ* enhanced bioremediation. Analytical results for samples collected as part of these activities suggest a mean reduction in TPH concentrations in soils over time (see Table 1-6). However, the relationship

between remediation efforts (particularly with regard to native tundra) and the apparent reduction in TPH concentrations has not been fully established. The extent to which natural biodegradation of diesel fuel has occurred in the native tundra is presently unknown. However, revegetation reported along the hillslope of the SS12-Spill No. 3 Site indicates that a reduction in TPH concentrations is likely occurring. The extent to which natural biodegradation of diesel fuel in soils and sediments, and in subsoils associated with near-beach groundwater contamination at Site ST05-Beach Tanks has occurred is presently unknown.

The only PCBs encountered in soils were identified in samples collected at two sites associated with the White Alice Station, the SS09-PCBs Spill Site (32 mg/kg), and the SS10-Solvent Spill Site (25 mg/kg). Excavation and removal of PCB contaminated soils from each site was conducted by WCC during Stage 2 RI/FS activities. PCBs were detected in a former water supply lake sediment sample at 3.4 mg/kg. The potential for PCBs to migrate from the White Alice Station to the lake is considered to be extremely low based on general site topography, an estimate of the permafrost slope, the extremely low estimated subsurface water flow rate, and the affinity of PCBs to bind to soil organic materials, which dominate the shallow subsurface lithology of the area.

Organochlorine pesticides were detected in soils and lake sediment samples collected at Kotzebue LRRS (see Table 1-3). The pesticides 4,4'-DDT and Lindane may have been used at the installation to control insects. The compounds 4,4'-DDD and 4,4'-DDE are transformation products of 4,4,-DDT; delta-BHC is a transformation product of gamma-BHC (Lindane).

2.2.2 Contaminant Source Identification

A review of available IRP investigation information was conducted to evaluate known sites currently representing potential contaminant source areas. A detailed description of the status of all identified sites and newly identified areas of concern is presented in Section 1.2.2.8, Current Site Status. No background contaminant concentrations have been established during previous IRP investigations that would assist in the definition of sample concentrations exceeding background. The following five potential contaminant source areas are identified on the basis of information obtained during previous investigations:

- ST05-Beach Tanks Site--Maximum detections of TPH (by Method 418.1) in soils at 21,000 mg/kg and in near-beach groundwater at 8,700 mg/L.

- SS12-Spills No. 2 and 3 Site--Although enhanced bioremediation activities and/or natural biodegradation have apparently contributed to a mean reduction in TPH concentration in native soils overtime, elevated TPH concentrations remain in gravel fill materials at this site. Pesticide 4,4'-DDT detected at 5.7 mg/kg in soil.

- SS08-Barracks Pad Site--Maximum detection of TPH in soil was 5,960 mg/kg and pesticide 4,4'-DDD at 0.19 mg/kg.

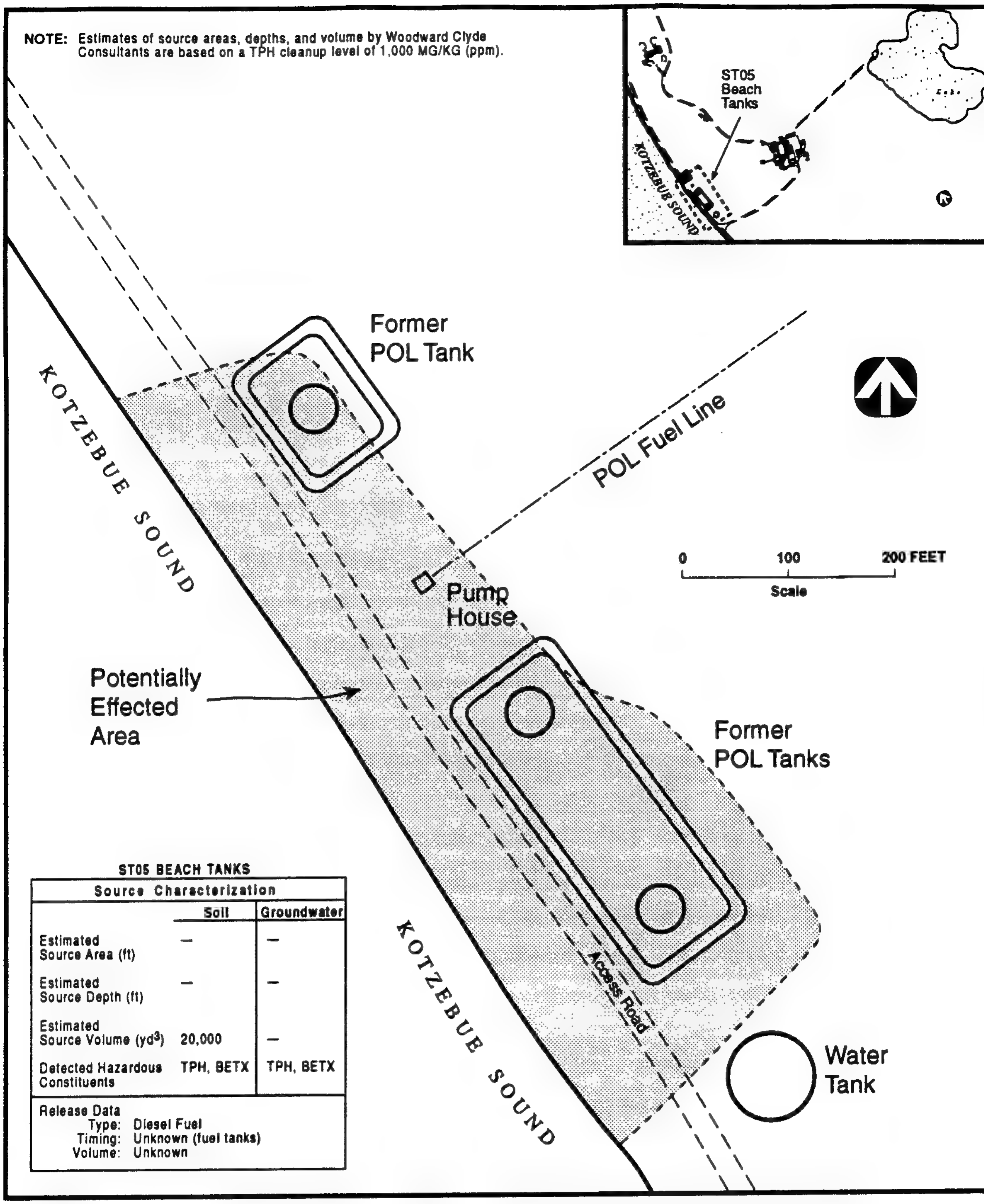
- SS11-Fuel Spill Site--Although natural biodegradation and/or enhanced bioremediation activities have apparently contributed to a mean reduction of TPH concentrations in soil over time, current site conditions are not known. The pesticide 4,4'-DDT was detected at 0.098 mg/kg in soil.

- AOC1-Landfarm--Although enhanced bioremediation activities have apparently contributed to a mean reduction of TPH concentrations in landfarm soils, elevated TPH concentrations are suspected. VOC, SVOC, and pesticide compounds have not been specifically analyzed for in landfarm soils.

Figures 2-3, 2-4, 2-5, and 2-6 provide source area identification and source characteristics data. Specific information regarding the timing, duration, and rate of hazardous substance releases from source areas is difficult to assess at many sites due to the lack of historical information regarding releases at Kotzebue LRRS. The soil TPH cleanup levels used by WCC to establish the areal extent and volume of contaminant source areas include 1,000 mg/kg at the ST05-Beach Tanks Site and 10,000 mg/kg at all other sites. The development of project cleanup goals for future IRP RI/FS activities at Kotzebue LRRS will directly affect the assessment of source area extent and volume for many sites.

In addition to the above identified source areas, the SS02-Waste Accumulation Area No. 2/Landfill and SS07-Lake sites will require further site investigation based on the following rationale:

- Site SS02-Waste Accumulation Area No 2./Landfill--The former Waste Accumulation Area No. 2 and Landfill area were used to contain and dispose of a variety of facility wastes. Site SS02 was cleaned and graded in mid-1970; however, no environmental

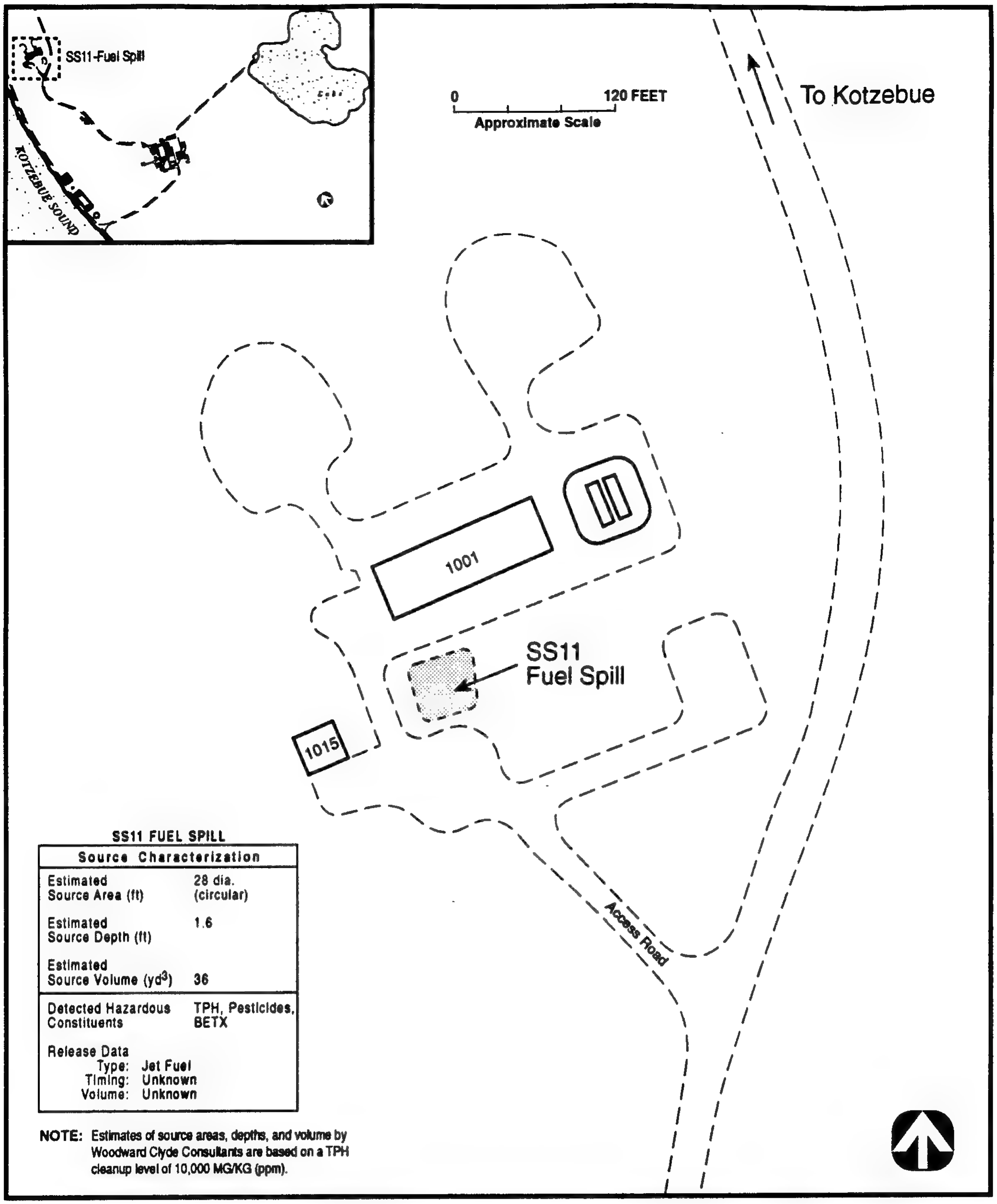


ST05 BEACH TANKS

Source Characterization	Soil	Groundwater
Estimated Source Area (ft)	—	—
Estimated Source Depth (ft)	—	—
Estimated Source Volume (yd^3)	20,000	—
Detected Hazardous Constituents	TPH, BETX	TPH, BETX

Release Data
Type: Diesel Fuel
Timing: Unknown (fuel tanks)
Volume: Unknown

Figure 2-3. Contaminant Source Characterization, ST05-Beach Tanks. Kotzebue LRRS, Alaska.



SS11 FUEL SPILL

Source Characterization	
Estimated Source Area (ft)	28 dia. (circular)
Estimated Source Depth (ft)	1.6
Estimated Source Volume (yd^3)	36
Detected Hazardous Constituents	TPH, Pesticides, BETX
Release Data	
Type:	Jet Fuel
Timing:	Unknown
Volume:	Unknown

NOTE: Estimates of source areas, depths, and volume by Woodward Clyde Consultants are based on a TPH cleanup level of 10,000 MG/KG (ppm).

Figure 2-4. Contaminant Source Characterization, SS11-Fuel Spill. Kotzebue LRRS, Alaska.

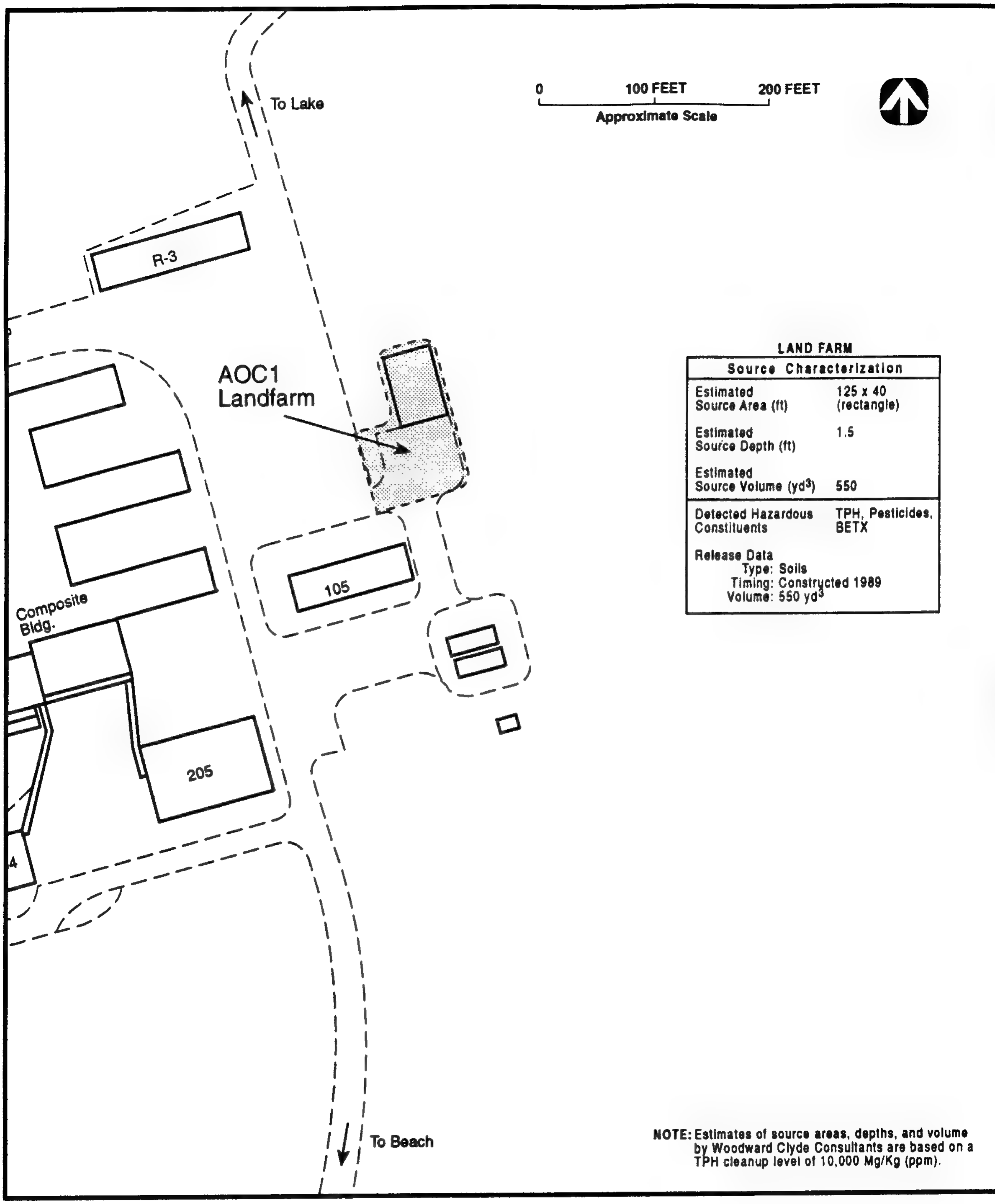


Figure 2-5. Contaminant Source Characterization, AOC1-Landfarm. Kotzebue LRRS, Alaska.

SS12 SPILL NO. 3

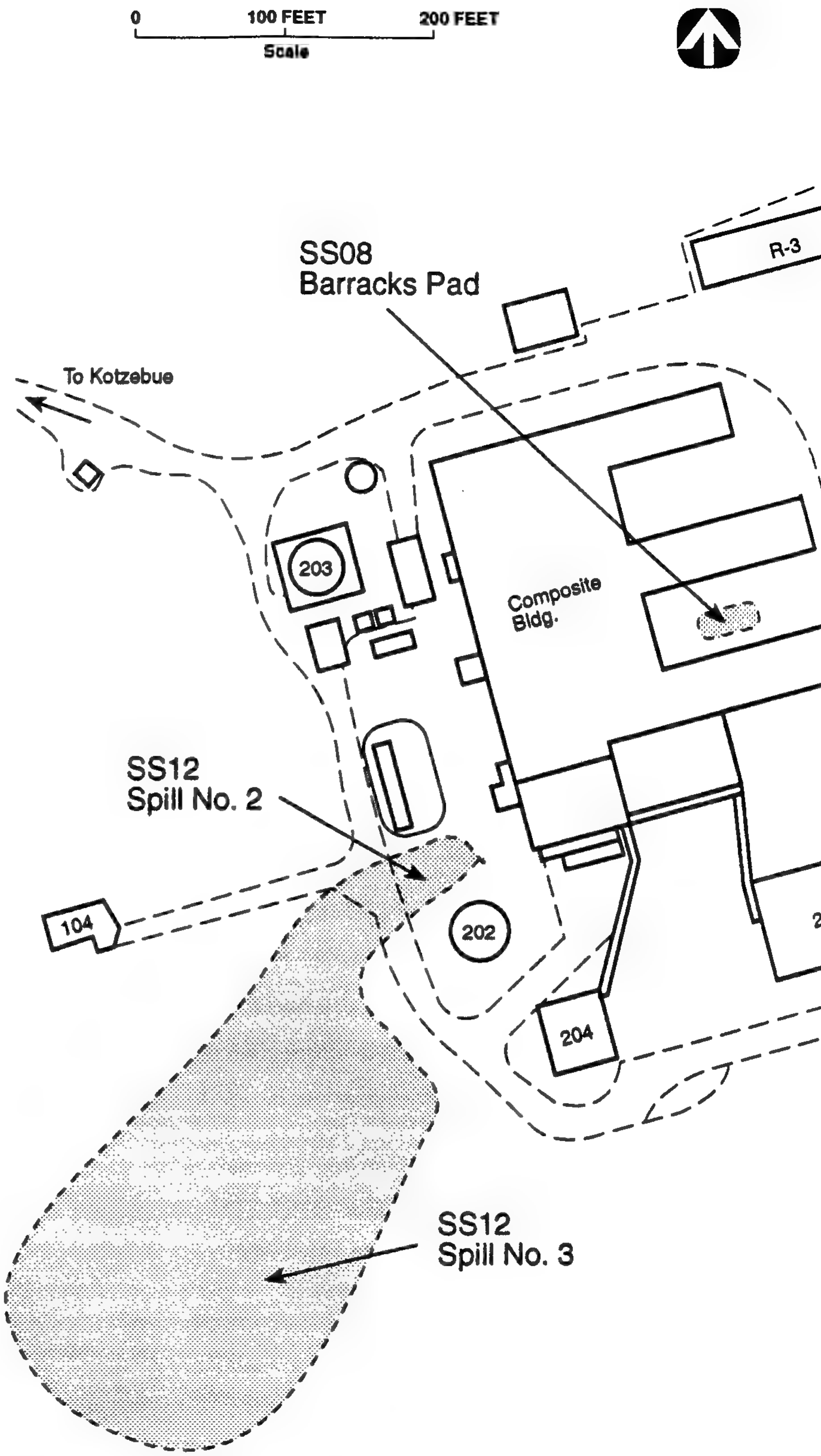
Source Characterization	Fill	Native Tundra
Estimated Source Area (ft)	40 x 27 (ellipse)	55 x 100 (ellipse)
Estimated Source Depth (ft)	3.5	0.5
Estimated Source Volume (yd^3)	450	100
Detected Hazardous Constituents	TPH, Pesticides, BETX	
Release Data Type: Timing: Volume:	 Diesel Fuel 1984 (hole in fuel line observed) unknown (4,000 gal recovered)	

SS12 SPILL NO. 2

Source Characterization	
Estimated Source Area (ft)	30 x 40 (elipse)
Estimated Source Depth (ft)	2.5
Estimated Source Volume (yd^3)	87
Detected Hazardous Constituents	TPH, Pesticides, BETX
Release Data Type: Timing: Volume:	 Diesel Fuel 1979-1980 (tank overfill) Unknown

SS08 BARRACKS PAD

Source Characterization	
Estimated Source Area (ft)	Not determined
Estimated Source Depth (ft)	Not determined
Estimated Source Volume (yd^3)	Not determined
Detected Hazardous Constituents	TPH, Pesticides
Release Data Type: Timing: Volume:	 Reportedly diesel fuel Unknown Unknown



NOTE: Estimates of source areas, depths, and volume Woodward Clyde Consultants are based on a TPH cleanup level of 10,000 Mg/Kg (ppm).

Figure 2-6. Contaminant Source Characterization, SS12-Spill No. 2 and 3 and SS08-Barracks Pad. Kotzebue LRRS, Alaska.

samples have previously been collected to evaluate site conditions. Scattered mounds of debris were identified in the former landfill area during the 1993 site survey.

- Site SS07-Lake--PCBs at 3.4 mg/kg and total DDT metabolites at 3.89 mg/kg were detected in a single sediment sample. ADEC has indicated concern regarding the source and extent of PCBs and DDT detected in the lake sediment samples.

2.2.3 Potential Migration Pathways

This section discusses contaminant migration pathways associated with potential contaminant source areas at Kotzebue LRRS including the groundwater, surface water, and air routes. Table 2-2 provides the chemical characteristics associated with specific organic compounds previously detected at Kotzebue LRRS. The chemical characteristics presented in Table 2-2 include critical fate and transport data necessary to evaluate general contaminant behavior in the Kotzebue LRRS environment.

2.2.3.1 Air. Contaminant transport via the air pathway can occur as a result of the volatilization of organic compounds from site source areas, and from airborne particulates (e.g., dust) containing contaminants identified in site soils. Volatile organic compounds (VOCs) related to petroleum hydrocarbon contamination, including benzene, ethylbenzene, toluene, and total xylene (BETX), have been detected at relatively low concentrations in site soils during previous IRP investigations. Benzene was detected at 0.86 mg/kg in a single soil sample from Site SS12-Spill No. 2. BETX compounds are characterized by their relatively high vapor pressures, and are potentially very volatile in the environment. However, contaminant transport in air via the volatilization mechanism, and subsequent pulmonary uptake by potential receptors, is considered relatively low at Kotzebue LRRS for the following reasons:

- Diesel fuel is the primary source of petroleum hydrocarbon contamination at Kotzebue LRRS. Diesel fuel contains approximately 10 percent BETX compounds by weight. The limited number of detections and the low concentration of BETX compounds encountered in previously characterized soils at Kotzebue LRRS suggests that a significant percentage of volatile constituents have volatilized, photolyzed, biodegraded, and/or leached from soils since release.

TABLE 2-2. CHEMICAL CHARACTERISTICS OF ORGANIC COMPOUNDS DETECTED AT KOTZEBUE LRRS, ALASKA					
	Chemical Characteristics				
Chemical Compound	Water Solubility (mg/L)	Vapor Pressure (mm Hg)	Henry's Law Constant (atm-m^3/mol)	K_{oc} [a] (mL/g)	K_{ow} [b]
Benzene	$1.75E^{+03}$	$9.52E^{+01}$	$5.59E^{-03}$	$8.30E^{+01}$	$1.32E^{+02}$
Toluene	$5.35E^{+02}$	$2.81E^{+01}$	$6.37E^{-03}$	$3.00E^{+02}$	$5.37E^{+02}$
Ethylbenzene	$1.52E^{+02}$	$7.00E^{+00}$	$6.43E^{-03}$	$1.10E^{+03}$	$1.41E^{+03}$
Total xylene	$1.98E^{+02}$	$1.00E^{+01}$	$7.04E^{-03}$	$2.40E^{+02}$	$1.82E^{+03}$
PCB Aroclor 1260	$3.10E^{-02}$	$7.70E^{-05}$	$1.07E^{-03}$	$5.30E^{+05}$	$1.10E^{+06}$
4,4'-DDD	$1.00E^{-01}$	$1.89E^{-06}$	$7.96E^{-06}$	$7.70E^{+05}$	$1.58E^{+06}$
4,4'-DDE	$4.00E^{-02}$	$6.50E^{-06}$	$6.80E^{-05}$	$4.40E^{+06}$	$1.00E^{+07}$
4,4'-DDT	$5.00E^{-03}$	$5.50E^{-06}$	$5.13E^{-04}$	$2.43E^{+05}$	$1.55E^{+06}$
Delta-BHC	$3.14E^{+01}$	$1.70E^{-05}$	$2.07E^{-07}$	$6.60E^{+03}$	$1.26E^{+04}$
2-Methylnaphthalene	$2.54E^{+01}$*	--	--	$8.50E^{+03}$*	$1.29E^{+04}$*

Source: U.S. EPA (1986). Superfund Public Health Evaluation Manual. Office of Emergency and Remedial Response, Washington, DC. EPA/540/1-86-060. *Taken from Ney, R.E. 1990.

[a] Adsorption coefficient.

[b] Octanal/water coefficient.

- Extreme climatic conditions limit the potential for volatilization at Kotzebue LRRS. Cold temperatures and frozen ground limits existing potential volatilization to approximately four months of the year. Additionally, precipitation in this region is greatest during the summer months, limiting the potential for volatilization of contaminants from source areas.

- The high soil moisture content and near-surface permafrost that characterizes the tundra hill and surrounding area limits the potential for volatilization at sites located above the beach area. Although volatile, BETX compounds are also characterized by relatively high water solubilities, and therefore may dissolve in surface and pore waters and subsequently diffuse from water at relatively slow rates.

In addition to volatilization, airborne particulates (dust) may provide a mechanism for contaminant transport via the air pathway at Kotzebue LRRS. The average wind speed for the Kotzebue area is relatively high (11 knots), with the prevailing wind direction out of the east-southeast. However, the same climatic conditions that limit the volatilization of contaminants from soil (frozen conditions, summer rainfall, saturated tundra) also limit the potential for dust generation at the installation. Additionally, the installation is located approximately four miles south of the City of Kotzebue. It is extremely unlikely that the eolian transport of contaminated soils from the installation could impact the town of Kotzebue.

*2.2.3.2 **Surface Water.*** The occurrence of surface water associated with Kotzebue LRRS and the surrounding area is identified and discussed in Section 2.1.5.1, Surface Water Occurrence. Kotzebue LRRS is situated atop a tundra hill located approximately 0.25 miles east of Kotzebue Sound. Most of the sites under investigation at Kotzebue LRRS range in elevation from 120 to 155 ft MSL, with the exception of Site SS02 and Site ST05, both of which are located adjacent to Kotzebue Sound. Surface water runoff originating from the installation is topographically directed either west toward Kotzebue Sound, or east toward nearby wetlands. Runoff draining east could potentially reach the former installation water supply lake. Table 2-1 presents surface water drainage features and directions for sites located at Kotzebue LRRS.

Melting of the annual snowpack usually occurs over a relatively short time period each year, referred to as break-up, and coincides with the greatest annual surface water flow at Kotzebue LRRS. Soils

reportedly remain frozen during much of break-up, limiting the depth to which contaminant migration can occur via surface water runoff during this period. That portion of the tundra surface not frozen and containing surface water is termed the active zone. Surface water infiltration rates have not been published for the Kotzebue area, but recharge to the tundra hill active zone is limited by the low average annual precipitation, extended periods of sub-freezing conditions, and the low intrinsic permeability of native soils.

Contaminant migration via surface water runoff at Kotzebue LRRS may result from contaminants sorbed onto entrained soil particles and/or from contaminants solubilized in rainwater or snowmelt. Organic compounds previously detected in site soils at Kotzebue LRRS include relatively mobile volatile aromatic hydrocarbons (e.g., BETX), and compounds that are generally much less volatile and mobile, such as pesticides and PCBs. Volatile compounds such as BETX are characterized by relatively high vapor pressures and water solubilities. BETX compounds generally volatilize readily in the surface environment due to their relatively high vapor pressures; however, they can also dissolve readily in surface and pore waters due to their high water solubilities, and may actually diffuse more slowly than less-soluble alkanes and alkenes (Baehr 1987). In general, petroleum hydrocarbons are readily photolizable, are readily metabolized by microorganisms (biodegraded), and do not tend to bioaccumulate in the environment.

Pesticides and PCBs are characterized by relatively to very low water solubilities and vapor pressures, and do not tend to volatilize at the surface or to readily leach into surface or pore waters. These compounds tend to adsorb to soil particles, as indicated by their high adsorption coefficients (Koc). Thus, the surface water transport of PCB compounds, and to a lesser degree pesticides, is restricted to contaminants adsorbed to soil particles. Pesticides and PCBs have a strong affinity to bioaccumulate in the environment, indicated by their relatively high octanol/water coefficients (Kow). These compounds do not readily biodegrade, but are susceptible to phototransformation.

Pesticides (total DDT metabolites) were detected at 3.89 mg/kg, and PCB (Aroclor 1260) at 3.4 mg/kg in a single sediment sample collected from the former installation water supply lake, but were not encountered in lake water samples. The only other PCBs encountered during previous IRP site investigations were in soils at the White Alice Station (later excavated), located approximately 0.5 miles

northwest of the lake. The potential for PCB migration from the White Alice Station via the surface water pathway to the former water supply lake is considered to be extremely low based on the general site topography and the strong affinity of PCBs to bind to soil organic matter.

2.2.3.3 Groundwater. The occurrence of groundwater associated with Kotzebue LRRS and the surrounding area is discussed in Section 2.1.4. Groundwater associated with the beach area at Kotzebue LRRS is restricted to a narrow zone adjacent to Kotzebue Sound, where the depth to permafrost (undetermined) is sufficiently depressed by marine influence to support a continuously saturated subsurface zone. The thickness of this aquifer system is not known, but is probably variable, and likely coincides with the depth to permafrost. Although permafrost was not encountered along the beach area during previous IRP investigations (maximum depth investigated = approximately 10 ft BGS), permafrost is encountered at shallow depths a short distance inland from the beach along the base of the sea cliffs.

Near-beach groundwater reportedly occurs between 3.0 and 3.5 ft BGS along the steepened beach face immediately adjacent to Kotzebue Sound, and from 6.2 to 7.7 ft BGS within the beach tank pads, based on data obtained from trenches installed during Stage 2 RI/FS field activities. Groundwater was not detected at a depth of 10 ft BGS along the base of the tundra hill based on a single soil boring installed during the Stage 1 RI/FS. The local groundwater flow direction is estimated to be to the southwest, toward Kotzebue Sound. Hydraulic gradient calculations are not presented for the near-beach aquifer system in previous investigation reports.

Physical parameters for the subsoil materials housing the near-beach aquifer that were measured during previous IRP investigations at Site ST05 include permeability and grain-size distribution. Hydraulic conductivity was estimated by conducting falling-head slug tests and using estimates from constant-head permeability tests and grain-size analyses. Two falling-head slug tests were conducted in a single piezometer at Site ST05 that provided hydraulic conductivity estimates of 30 ft/day and 3.2 ft/day. These hydraulic conductivity values are not representative of actual conditions for several reasons, including static water levels below the top of the piezometer screen. Thus, measurement of unsaturated portions of the water-table aquifer were made, yielding variable, non-representative data. Two constant-head permeability laboratory tests were conducted on beach sediment samples collected from trenches installed at Site ST05. The permeability test results include hydraulic conductivity estimates of 3.8 ft/day for a sample collected near the beach tank pads and 9.7 ft/day for a sample collected downgradient of the beach

tanks along the steepened beach face. Grain-size analyses were conducted on beach sediments collected from trenches installed adjacent to the beach tanks and along the steepened beach face. Two grain-size distribution analyses were conducted on beach sediments collected from locations similar to those for the permeability test samples. Grain-size distribution results indicate that both sediments are gravelly sands.

Previous IRP site characterization studies indicate that the local near-beach groundwater system is influenced by Kotzebue Sound tidal fluctuations. The mean tidal range is 2.1 ft at the nearest location where tidal corrections have been established (Kiwalik, Kotzebue Sound); the diurnal tidal range at Kiwalik is 2.7 ft (NOAA 1990). However, previous investigations of tidal influence at the ST05-Beach Tanks Site have not been quantified relative to a common datum. Tidal influences on the aquifer system can directly affect aquifer gradients and geochemistry, influencing contaminant migration and impacting an evaluation of remedial alternatives.

Recharge of the near-beach aquifer system has not been addressed by previous studies. Recharge of the beach aquifer is likely controlled by the highly seasonal nature of active zone (suprapermafrost water) inputs that recharge the beach area from the tundra uplands. Kotzebue Sound tidal influence on the system, together with the seasonal nature of freshwater recharge, may result in significant seasonal changes with respect to salinity and geochemistry; gradients may also be affected.

Subsoils and groundwater samples collected at Site ST05 have yielded detections of residual TPH and of the purgeable aromatic hydrocarbons ethylbenzene, toluene, and xylenes. Previous IRP site characterization data for the beach tanks area obtained in 1989 yield a maximum residual TPH concentration in groundwater of 8,700 mg/L. This concentration suggests a slight potential for the existence of free product or sheen on the water table over a limited area. Purgeable aromatic hydrocarbon compounds detected in Site ST05 groundwater samples collected in 1989 reveal relatively low maximum concentrations, with ethylbenzene at 0.0063 mg/L, toluene at 0.034 mg/L, and xylenes at 0.140 mg/L.

An arctic-grade diesel hydrocarbon source yielding the relatively high residual TPH values presented above would be expected to yield higher purgeable aromatic hydrocarbon values than have been observed at Site ST05. The data presented in previous investigation reports suggest that light-fraction components have been greatly reduced by photolysis, volatilization, biodegradation, and/or other weathering processes. The release date(s) for the contamination is not known. The absence of data along flow paths

in the beach aquifer system hinders an evaluation of other potential sources of light-fraction petroleum concentration reductions, including but not limited to dispersion, diffusion, hydrolysis, in addition to the processes mentioned above.

Because light-fraction (e.g., purgeable aromatic) hydrocarbons are significantly more toxic to ecological and potential human receptors, and are significantly more mobile in groundwater than are residual range hydrocarbons, the historically observed contaminant distribution suggests that the ST05 source area may not pose an imminent hazard to Kotzebue Sound. The current contaminant distribution (both vertically and along the beach) in the vicinity of the beach tanks source area must be further evaluated to better constrain the site conceptual model and evaluate potential risks.

2.2.4 Potential Receptors

Potential human and ecological receptors associated with Kotzebue LRRS are discussed in the following sections. Potential contaminant migration pathways were evaluated for five identified source areas. Based on this assessment, the five principal source areas have been combined into three groups on the basis of similar contaminant characteristics and potential migration pathways. This three-fold division is comprised of: 1) Site ST05-Beach Tanks; 2) Site SS12-Spills No. 2 and 3; and 3) the AOC1-Landfarm, Site SS08-Barracks Pad, and Site SS11-Fuel Spill. Potential human and ecological receptors (terrestrial and aquatic) were identified for each of the three site groups. Conceptual exposure pathways for human and ecological receptors are presented in Figures 2-7 through 2-12. Figure 2-13 presents a cross-sectional view of the topography and stratigraphy at Kotzebue LRRS between the Composite Facility and the ST05-Beach Tanks Site to aid in the interpretation of pathways and receptors.

2.2.4.1 Human Receptors. Potential human receptors at Kotzebue LRRS include USAF personnel and radar maintenance technicians who service the installation, and local subsistence and recreational users. Subsistence use may include berry picking in adjacent wetlands, terrestrial hunting along the tundra hill and surrounding area, and marine hunting and fishing in Kotzebue Sound and along the beach area. Potential recreational uses include ATV use on roads and beach areas, beach combing and summer picnicking along beach areas, and recreational hunting and fishing.

2.2.4.2 Ecological Receptors. Terrestrial and aquatic habitats for plants and animals associated with Kotzebue LRRS are discussed in Section 2.1, Environmental Setting. A general description of the native

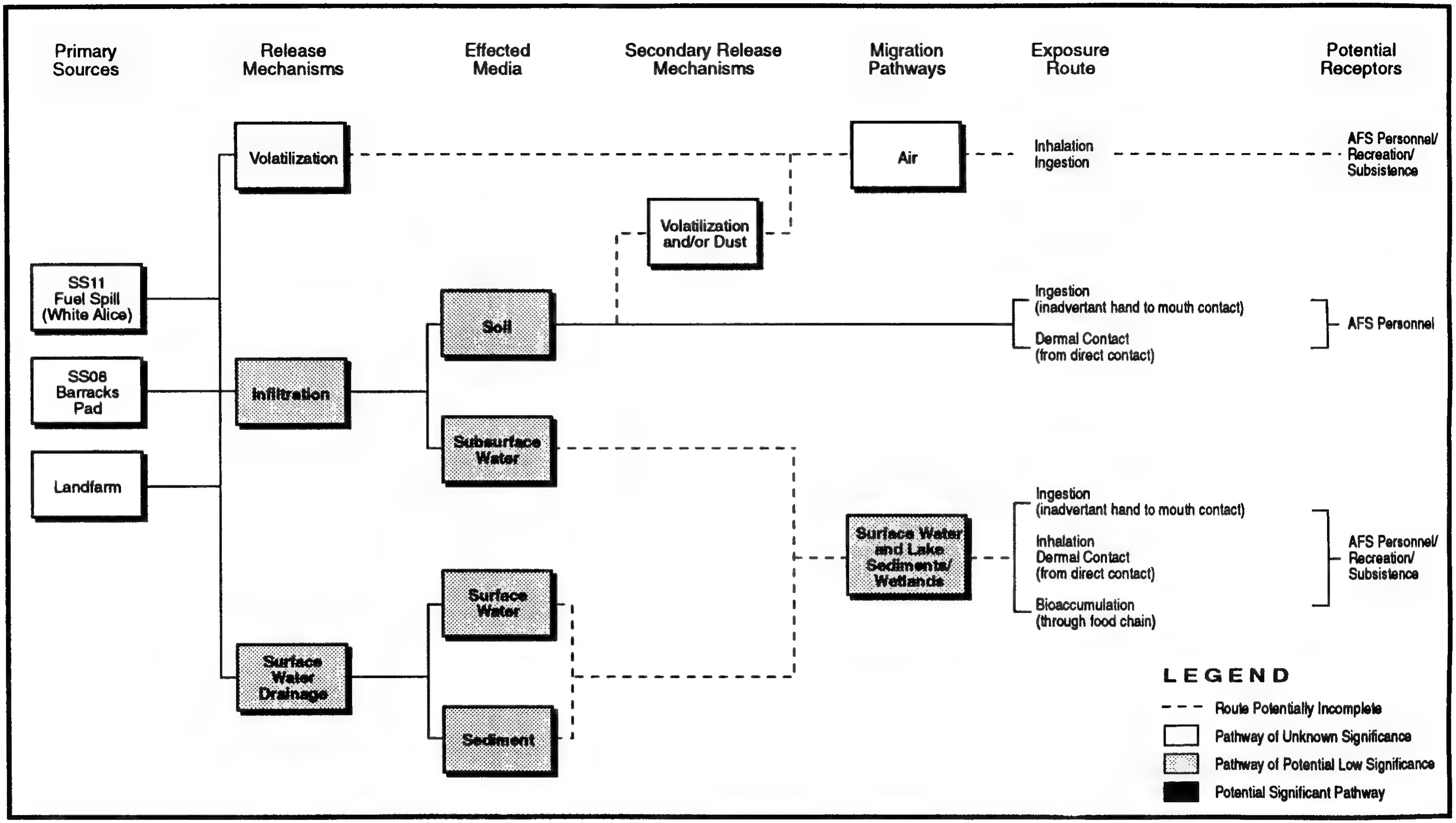


Figure 2-7. Conceptual Exposure Pathway for SS08-Barracks Pad, SS11-Fuel Spill, and AOC1-Landfarm: Potential Human Receptors. Kotzebue LRRS, Alaska.

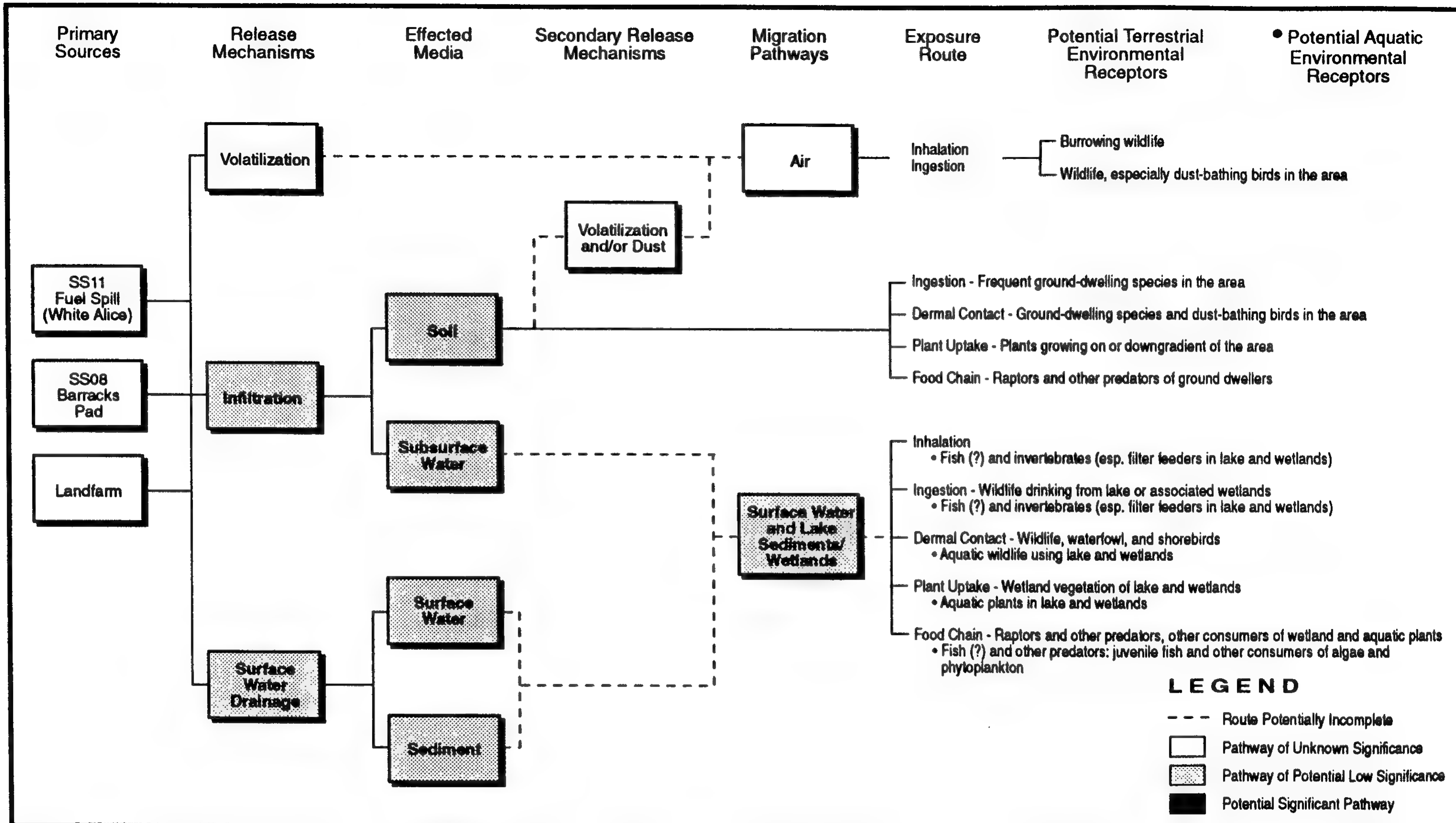


Figure 2-8. Conceptual Exposure Pathway for SS08-Barracks Pad, SS11-Fuel Spill, and AOC1-Landfarm: Potential Ecological Receptors. Kotzebue LRRS, Alaska.

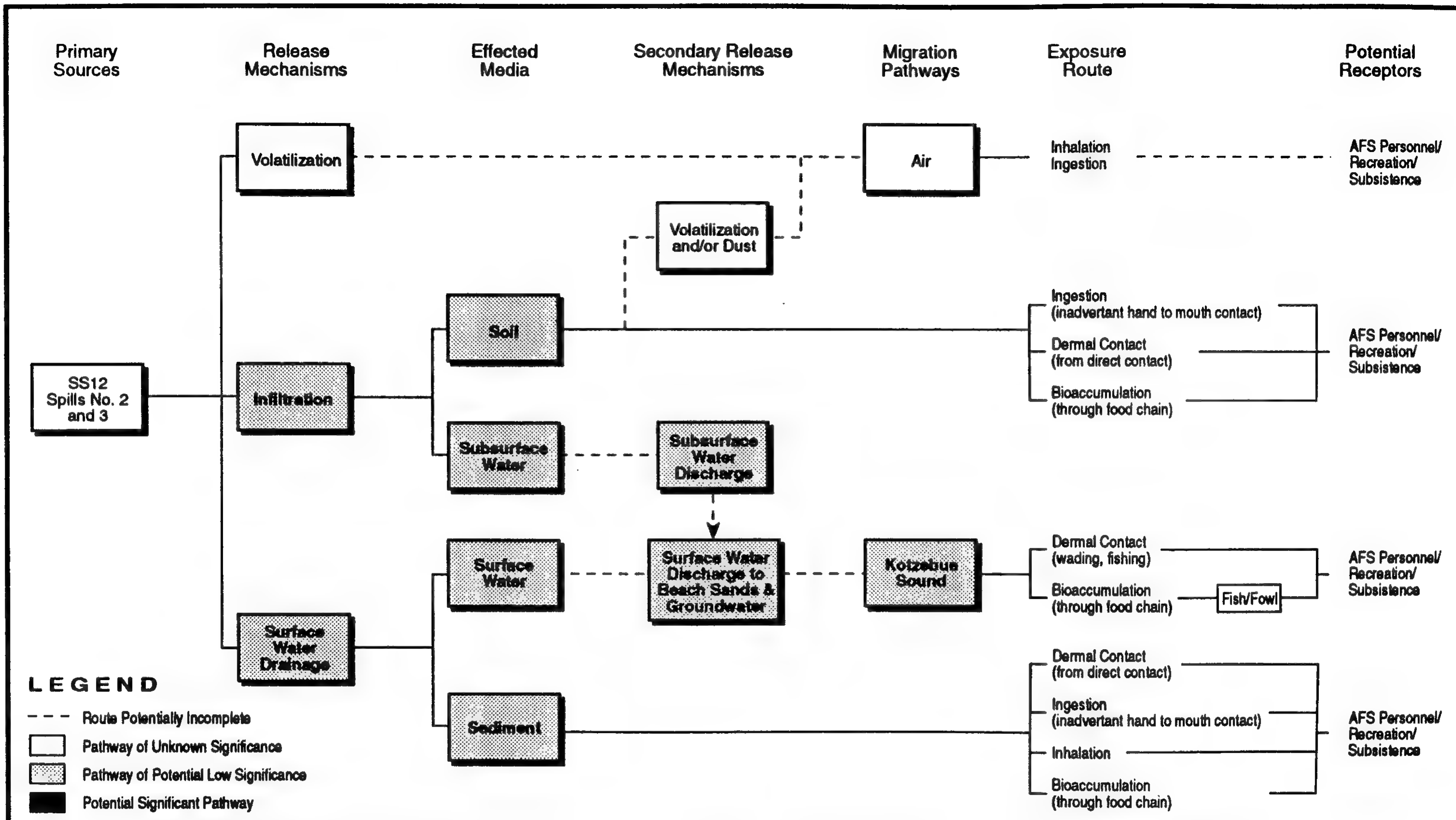


Figure 2-9. Conceptual Exposure Pathway for SS12-Spill No. 2 and 3: Potential Human Receptors. Kotzebue LRRS, Alaska.

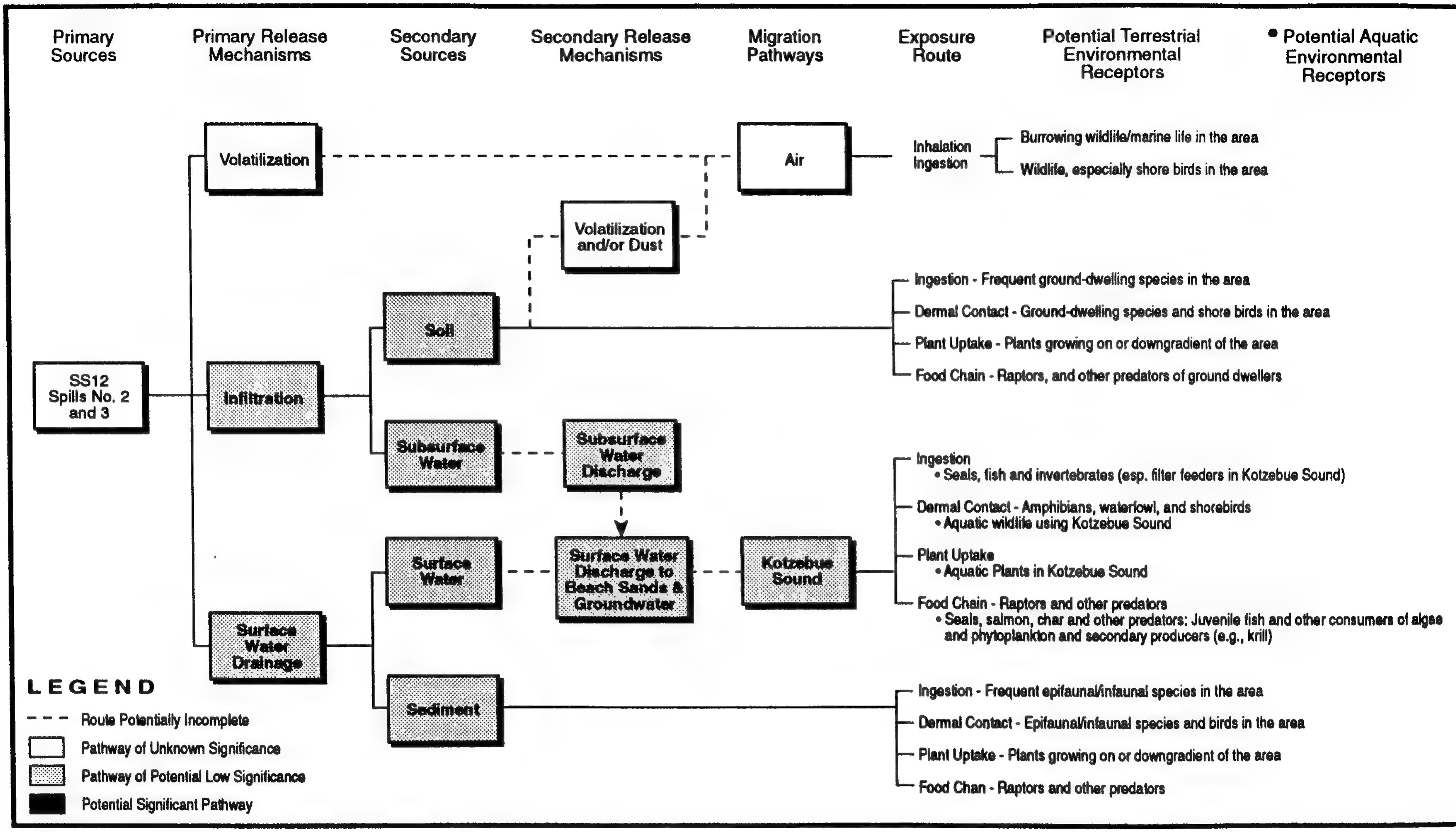


Figure 2-10. Conceptual Exposure Pathway for SS12-Spills No. 2 and 3: Potential Ecological Receptors. Kotzebue LRRS, Alaska.

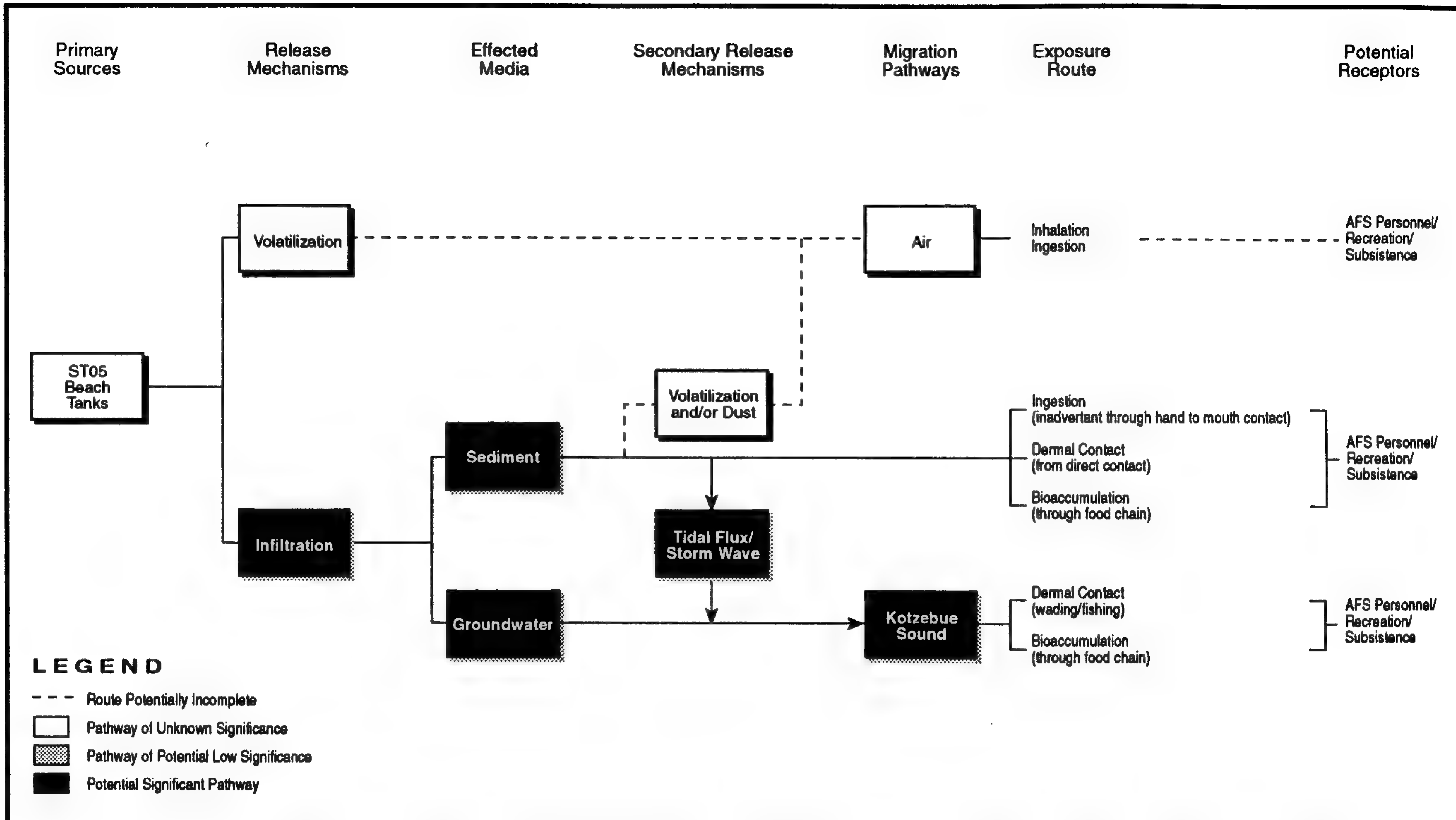


Figure 2-11. Conceptual Exposure Pathway for ST05-Beach Tanks: Potential Human Receptors. Kotzebue LRRS, Alaska.

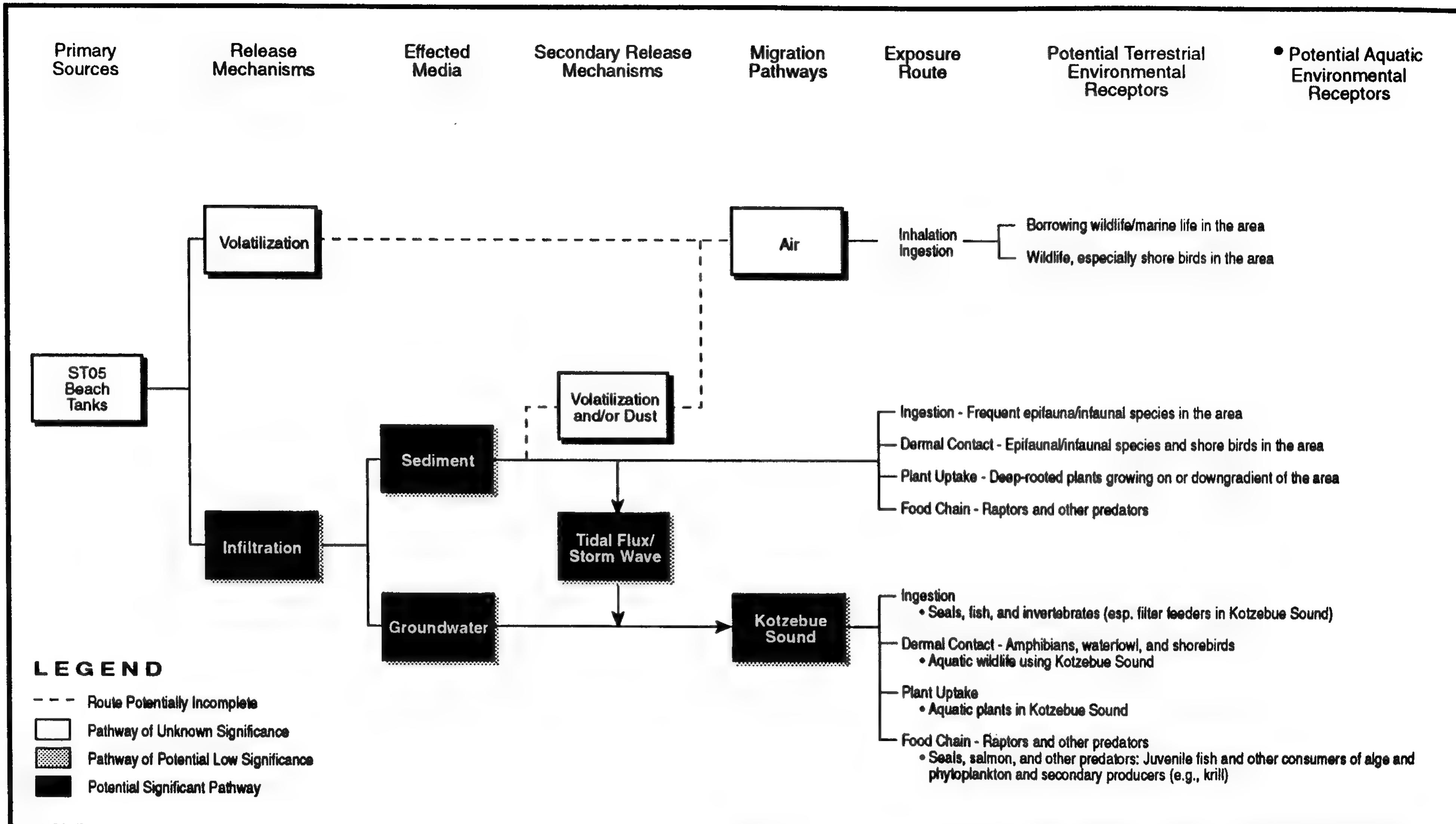


Figure 2-12. Conceptual Exposure Pathway for ST05-Beach Tanks: Potential Ecological Receptors. Kotzebue LRRS, Alaska.

potential remedial actions to an approximate three month working period each year. The moist native tundra environment surrounding Kotzebue LRRS is considered to be fragile, and remedial actions that do not cause damage to tundra and underlying permafrost are favored.

ADEC has indicated that Kotzebue LRRS sites will likely be regulated under the Water Quality Standard Regulations (18 AAC 70; December 1989). Revisions to the water quality standard regulations were proposed by the ADEC Water Quality Management Section in August 1993. ADEC has provided a target level for TPH (diesel range) contaminated soils of 1,000 mg/kg for Kotzebue LRRS sites located on the tundra hill and surrounding areas (personal communication with L. Nolan). The 1,000 mg/kg TPH (diesel range) target level for soils will be used to establish the vertical and lateral extent of petroleum contamination at sites during the remedial investigation, and to provide a bench mark with which to evaluate the applicability and potential cost of remedial alternatives identified during the subsequent feasibility study. In defining the lateral and vertical extent of contamination using this target level, numerous samples will be collected with lower levels of TPH contamination to adequately define zones exceeding 1,000 mg/kg diesel-range TPH in soil. Petroleum hydrocarbon contaminated soils and ground-water associated with the ST05-Beach Tanks Site, located adjacent to Kotzebue Sound, will require additional remedial investigation to determine current site conditions and to provide the data necessary to evaluate remedial alternatives.

The USAF is currently considering the following interim remedial actions to be conducted during the 1994 field season in support of the Kotzebue LRRS IRP RI/FS:

- Limited excavation and stockpiling of identified TPH source materials (e.g, Site SS12-Spills No. 2 and 3).

- Removal of above ground storage tanks (e.g., AOC3-East Tanks and AOC9-White Alice Tanks), and limited excavation and stockpiling of contaminated soils, if necessary.

- Repair of the containment structure, or recontainment of AOC1-Landfarm soils.

2.4 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARS)

The U.S. Environmental Protection Agency (EPA) has defined what constitutes an Applicable or Relevant and Appropriate Requirement (ARAR) as those promulgated regulations that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site. Promulgated requirements are those laws and regulations that are of general applicability and are legally enforceable. EPA specifically states in the ARAR guideline document [Section 120 of CERCLA (10 USC 2701 et seq.)], that nonpromulgated advisories and guidance documents issued by federal or state governments do not have the status of potential ARARs, but may be used to determine the level of cleanup necessary to protect human health and the environment. For a regulation to be applicable, it must satisfy all jurisdictional prerequisites of the requirement.

A regulation may be relevant and appropriate, even if it is not applicable as defined above. According to EPA, relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements that address problems or situations sufficiently similar to those encountered at a CERCLA site. Kotzebue LRRS is not on the National Priority List (NPL) of ranked CERCLA sites; however, the use of these requirements is appropriate at Kotzebue LRRS, as the identification of ARARs is a critical part of the RI/FS process. EPA classifies ARARs into three groups:

- Ambient or chemical-specific requirements that set concentration limits for an element or chemical compound in various environmental media such as ambient water, drinking water, ambient air, soil, or solid waste

- Performance, design, or technical requirements (e.g., regulations for the closure of hazardous waste landfills), RCRA incineration standards, RCRA land disposal restrictions, and pretreatment standards for discharges to Publicly Owned Treatment Works (POTWs)

- Location-specific requirements or siting restrictions (e.g., industrial vs. residential properties, native vs. disturbed tundra, etc.).

Group 1 requirements set health or risk-based concentration limits or ranges in various environmental media for specific hazardous substances, pollutants, or contaminants. Regulations in Groups 2 and 3 are applicable if industrial processes or remedial actions include the generation, transport, treatment, or disposal of regulated hazardous wastes or contaminated environmental media.

2.4.1 Summary of Detected Contaminants

Table 2-3 lists the contaminants and sample matrix for each compound detected at the Kotzebue LRRS sites during previous IRP RI/FS investigations. The maximum concentration of organic compounds and metals detected in soils, surface water, and groundwater samples collected during previous IRP investigations are presented in Section 1.2.2 of this report. Preliminary identification of ARARs addressing chemical-specific requirements were based on the reported detections of contaminants during previous IRP investigations. Maximum contaminant concentration data will be used, in part, to further refine the list of potential ARARs.

2.4.2 Preliminary Identification of ARARs

The following is a preliminary list of general federal and state statutes and regulations that could serve as potential ARARs for Kotzebue LRRS. Some ARARs listed below contain specific sections, chapters, or parts that may be relevant to a specific contaminant, location, or remedial process. Specific ARARs as well as the general statutes and regulations are listed in Tables 2-4 and 2-5.

<u>Federal ARARs</u>

- Clean Water Act (CWA)
- Clean Air Act (CAA)
- Resource Conservation and Recovery Act (RCRA)
- Occupational Safety and Health Act (OSHA)
- Fish and Wildlife Coordination Act (FWCA)
- Endangered Species Act (ESA)
- Rivers and Harbors Act of 1989
- Coastal Zone Management Act (CZMA)
- Marine Protection, Research and Sanctuaries Act (MPRSA)
- Toxic Substances Control Act (TSCA)

TABLE 2-3. CONTAMINANTS DETECTED DURING PREVIOUS IRP RI/FS INVESTIGATIONS CONDUCTED AT KOTZEBUE LRRS

Contaminant	Matrix			
	Soil	Water	Sediment	Air[a]
Total Petroleum hydrocarbons (TPH)[b]	Yes	Yes	No	No
Benzene[b]	Yes	No	No	No
Toluene[b]	Yes	Yes	No	No
Ethylbenzene[b]	Yes	Yes	No	No
Total Xylenes[b]	Yes	Yes	No	No
2-Methylnaphalene[b]	Yes	Yes	No	No
Metals (EPA priority pollutant)[c]	Yes	No	Yes	No
Aroclor-1260 (PCB)[d]	Yes	No	Yes	No
4,4'-DDT[e]	Yes	No	Yes	No
4,4'-DDD[e]	Yes	No	Yes	No
4,4'-DDE[e]	Yes	No	No	No
Delta-BHC[e]	Yes	No	No	No
Acetone[f]	Yes	Yes	No	No
2-Butanone[f]	Yes	No	No	No
Trichlorofluoromethane[f]	Yes	No	No	No

[a] No air samples were collected.

[b] Substances found in petroleum-based fuels, such as diesel fuel.

c Priority pollutant metals were detected at relatively low concentrations. However, background characterization was not conducted as part of previous IRP remedial investigations.

[d] PCB, Polychlorinated biphenyl.

[e] DDT and delta-BHC are common constituents of insecticides. EPA banned the use of DDT in 1972. DDD and DDE are principle breakdown products of DDT.

[f] Substance is a common laboratory agent. The presence of this substance is reportedly the result of laboratory contamination and not actual field condition.

TABLE 2-4. PRELIMINARY IDENTIFICATION OF FEDERAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARS) FOR KOTZEBUE LRRS IRP REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROGRAM.
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Federal Statute	Regulation	Description	Chemical Specific	Location Specific	Action Specific*	Preliminary Rationale for Selection or Exclusion
Safe Drinking Water Act (SDWA), National Primary Drinking Water Regulations	42 USC Section 300(f); 40 CFR Part 141	Establishes standards for current and potential drinking water supplies by setting maximum contaminant levels (MCLs) and non-zero maximum contaminant level goals (MCLGs).	X			EXCLUDED-There are no drinking water supplies within 3 miles of the installation. Near-beach groundwater is non-potable (brakish).
Federal Water Pollution Control Act [Clean Water Act (CWA)]	33 USC Section 1251-1376	Effluent discharge standards, ocean discharge requirements, and water quality criteria.	X		X	SELECTED-Water quality criteria are applicable.
CWA	40 CFR Part 122 & 125	Establishes the NPDES program which requires the permitting of a point discharge into marine or surface waters of the U.S. in Alaska; the NPDES program is administered by U.S. EPA Region 10.	X	X	X	POTENTIALLY SELECTED-Point source discharges may be applicable depending on remedial measures selected.
CWA	40 CFR Part 129	Establishes toxic pollutant effluent standards or prohibitions for certain toxic pollutants; aldrin/dieldrin, DDT/DDD/DDE, endrin, toxaphene, benzidine, and PCBs.	X		X	POTENTIALLY SELECTED-May be applicable if treatment/remediation process generates effluent.
CWA	40 CFR Part 131	Establishes water quality criteria based on toxic effects on human health and aquatic life.	X			SELECTED-May be applicable for the protection of aquatic life and risk evaluation.
CWA	Section 404	Requires that actions must be taken to avoid adverse effects in wetlands and prohibits discharges to wetlands.		X	X	SELECTED-There are wetlands in the surrounding subject vicinity.
CWA	Section 402; 42 CFR Part 1342	Establishes effluent standards to ensure state ambient water quality standards are met in receiving waters.	X			SELECTED-Potential basis for remediation criteria for surface waters.
Clean Air Act (CAA)	42 USC Sections 7401-7602; 40 CFR Part 50	Establishes standards for national ambient air quality necessary to protect human health and welfare.	X		X	POTENTIALLY SELECTED-May be applicable depending on the remedial technologies selected.
CAA	40 CFR Part 61	Establishes national emission standards for hazardous air pollutants (NESHAP).	X			POTENTIALLY SELECTED-May be applicable depending on the remedial technologies selected.
Resource Conservation and Recovery Act (RCRA)	40 CFR Part 261	Sets standards for determining if a waste is a hazardous waste.	X			SELECTED-Site contaminants will be compared against standards.
RCRA	40 CFR Part 261, Subpart C, Sect. 261.24	Defines hazardous waste by use of toxicity characteristics leaching potential test.	X			SELECTED-May be applicable depending on site contaminants and associated concentrations.
RCRA	40 CFR Parts 264 and 265, Subparts A-E	Requires persons treating, storing, or disposing of hazardous waste meet set of facility standards, draft a contingency plan, and meet recordkeeping/reporting standards.			X	POTENTIALLY SELECTED-If the waste is determined to be hazardous, it will be either treated or temporarily stored onsite.
RCRA	40 CFR Parts 264 and 265, Subpart I	Sets standards for persons storing or treating hazardous waste in containers.			X	POTENTIALLY SELECTED-Potentially applies if hazardous wastes are treated or stored.

TABLE 2-4. PRELIMINARY IDENTIFICATION OF FEDERAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARS) FOR KOTZEBUE LRRS IRP REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROGRAM.
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Federal Statute	Regulation	Description	Chemical Specific	Location Specific	Action Specific*	Preliminary Rationale for Selection or Exclusion
RCRA	40 CFR Parts 264 and 265, Subpart J	Sets standards for persons storing or treating hazardous waste in tanks.			X	POTENTIALLY SELECTED-Potentially applies if hazardous wastes are treated or stored.
RCRA	40 CFR Parts 264 and 265, Subpart L	Establishes regulations for persons storing or treating hazardous waste in piles.			X	POTENTIALLY SELECTED-Potentially applies if hazardous wastes are treated or stored.
RCRA	40 CFR Parts 264 and 265, Subpart O	Establishes regulations for persons treating hazardous waste in incinerators.			X	POTENTIALLY SELECTED-Potentially applies depending on remedial action.
RCRA	40 CFR Part 268	Identifies hazardous wastes restricted from land disposal.	X		X	SELECTED-Site contaminants will be compared against standards.
RCRA	40 CFR Parts 268, Subpart D	Requires hazardous waste to be treated to specific standards before it can be landfilled.	X		X	POTENTIALLY SELECTED-Depends on detected contaminants and their concentration.
RCRA	40 CFR Part 270	Establishes regulations which include permitting requirements for facilities that treat, store, or dispose of hazardous wastes.	X		X	POTENTIALLY SELECTED-Storage and onsite treatment of hazardous wastes could require permitting.
RCRA	--	Establishes regulation that new treatment, storage, or disposal of hazardous waste is prohibited within the 100-year floodplain.		X	X	POTENTIALLY SELECTED-Beach area at Kotzebue LRRS may be considered within 100-year floodplain.
Occupational Safety and Health Act (OSHA)	29 CFR 1910	Establishes requirements applicable to worker exposures during response actions at RCRA and CERCLA sites.		X		SELECTED-Applicable for all field work performed.
Fish & Wildlife Coordination Act (FWCA)	16 USC Section 661-666; 40 CFR Part 6, Subpart C, Sect. 6.302(g); 33 CFR Parts 320-330	Requires consultation when federal agency proposes/ authorizes modifications to streams or other water bodies (including wetlands) to provide adequate protection of fish/wildlife resources and to take actions to prevent loss or damage to these resources.		X	X	EXCLUDED-No waterbodies (including wetlands) will be modified.
Endangered Species Act (ESA)	16 USC Sections 1531-1543	Requires that federal agencies ensure that any action authorized, funded, or carried out by the agency is not likely to jeopardize the continued existence of any threatened/ endangered species, or destroy or adversely modify critical habitat.		X	X	POTENTIALLY SELECTED-No threatened/ endangered species are identified. However, wetlands may be considered a critical habitat.
ESA	40 CFR Part 6, Subpart C, Sect. 6.302 (h)	If a listed species is present, a biological assessment is required to examine any possible impacts upon the species or habitat.		X	X	EXCLUDED-No listed species are present.

TABLE 2-4. PRELIMINARY IDENTIFICATION OF FEDERAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARS) FOR KOTZEBUE LRRS IRP REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROGRAM.
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Federal Statute	Regulation	Description	Chemical Specific	Location Specific	Action Specific*	Preliminary Rationale for Selection or Exclusion
Coastal Zone Management Act (CZMA)	16 USC Sections 1451-1464	Prohibits federal agencies from undertaking any activity in or affecting a state's coastal zone that is not consistent with the state's approved CZMA program. Coastal zones are identified as "coastal waters and the adjacent shorelines strongly influenced by each other" and includes the water and lands therein and thereunder.		X	X	POTENTIALLY SELECTED-Site(s) along Kotzebue Sound may impact shoreline. Remedial actions may require consideration of CZMA statute.
Wild & Scenic Rivers Act (WSRA)	36 CFR Part 297	Federal agencies may not assist in construction of water resources projects that would have direct and adverse effect on free-flowing scenic, natural, recreational, fish and wildlife values for which a river on the system or inventory was established. Indirect effects from above or below rivers and on adjacent shorelines are also covered. Projects include dams, water conduits, discharge to waters, dredging, and shoreline development.		X	X	EXCLUDED-No water resource project relating to this project will be constructed at Kotzebue LRRS.
Rivers & Harbors Act of 1989	33 USC Section 403 33 CFR Parts 320-330	Requires Section 10 permits for structures or work in or affecting navigable waters.		X	X	EXCLUDED-No structures or work in or affecting navigable waters (Kotzebue Sound) is anticipated.
Executive Order #11990 on Protection of Wetlands	EO #11990 and 40 CFR Part 6, Subpart C, Sect. 6.302(a) and Appendix A	Requires federal agencies to avoid the adverse impacts associated with the destruction or loss of wetlands; to avoid new construction in wetlands if alternatives exist; and to develop mitigative measures if adverse impacts are unavoidable.		X	X	POTENTIALLY SELECTED-Wetlands are situated in the general vicinity of sites.
Executive Order #11988 on Protection of Floodplains	EO #11988 and 40 CFR Part 6, Subpart C, Sect. 6.302(b) & Appendix A	Requires federal agencies to evaluate the potential effects of actions they may take in a floodplain to avoid the adverse impacts associated with direct and indirect development of a floodplain.			X	POTENTIALLY SELECTED-Beach area at Kotzebue LRRS may be considered located in a coastal flood hazard zone.
Marine Protection, Research & Sanctuaries Act (MPRSA)	33 USC Parts 1401-1445	Prohibits dumping into the ocean any material that adversely affects the marine environment.			X	POTENTIALLY SELECTED-May be applicable depending on remedial action selection.
Toxic Substances Control Act (TSCA)	40 CFR Part 761	Establishes storage, disposal, and spill clean-up requirements for PCBs.	X		X	POTENTIALLY SELECTED-May be applicable to remediation of certain sites if PCBs detected.
Migratory Bird Treaty Act of 1972	16 USC Sections 703-708-, 109a-711	Provides protection for almost all native birds in the U.S. from unregulated and unintentional "take", which includes poisoning from hazardous wastes.			X	POTENTIALLY SELECTED-Could apply if sites pose significant risk.

TABLE 2-4. PRELIMINARY IDENTIFICATION OF FEDERAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARS) FOR KOTZEBUE LRRS IRP REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROGRAM.
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Federal Statute	Regulation	Description	Chemical Specific	Location Specific	Action Specific*	Preliminary Rationale for Selection or Exclusion
Marine Mammal Protection Act	16 USC Section 1374	Provide protection for almost all marine mammals in the U.S. from unregulated and unintentional "take", which includes poisoning from hazardous wastes and human disturbances.		X	X	POTENTIALLY SELECTED-Could apply if sites pose significant risk.
Fish & Wildlife Conservation Act of 1980	16 USC Section 1901 and 50 CFR Part 83	Provide for consideration of impacts on wetlands, protected habitats, and fisheries.		X	X	POTENTIALLY SELECTED-May apply depending on site conditions and/or remedial actions conducted.
Wilderness Act	16 USC Section 1131 -et seq.	Establishes the Wilderness Preservation Systems in order to preserve the wilderness character of these units and leave them unimpaired for future uses; compliance with prohibitions on activities in the wilderness area is required.		X	X	EXCLUDED-Kotzebue LRRS is not a designated wilderness preservation system.
National Historical Preservation Act	16 USC 470 et seq; 36 CFR Part 800	Prohibits the alteration of terrain that threatens significant scientific, prehistorical, historical, or archaeological data; action to recover and preserve artifacts.		X	X	POTENTIALLY SELECTED-Native American artifacts may exist within installation boundaries.

* Selection/Exclusion rationale is dependent on future actions.

TABLE 2-5. PRELIMINARY IDENTIFICATION OF STATE APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARS) FOR KOTZEBUE LRRS IRP REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROGRAM
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Title 18. Environmental Conservation	State Regulation	Description	Chemical Specific	Location Specific	Action Specific*	Preliminary Rationale for Selection or Exclusion
Air Quality Control (AQC) Chapter 50	18 AAC 50.010-18 AAC 50.900	Sets standards for air quality control	X	X	X	POTENTIALLY SELECTED-Potentially applicable depending on remedial technologies selected.
Solid Waste Management (SWM) Chapter 60	18 AAC 60.010- 18 AAC 60.910	Sets standards for solid waste management	X	X	X	POTENTIALLY SELECTED-May be applicable for certain remedial actions.
SWM	18 AAC 60.15	Sets criteria for long-term storage of solid waste on-site			X	POTENTIALLY SELECTED-May be applicable if contaminated material is stored on-site.
SWM	18 AAC 60.025	Sets criteria for the transportation of a solid waste			X	POTENTIALLY SELECTED-May be applicable if contaminated media are transported off-site.
SWM	18 ACC 60.75	Sets guidelines for landspreading, a passive remedial technology			X	POTENTIALLY SELECTED-May be applicable if landspreading is implemented as a remedial technology.
Hazardous Waste (HW) Chapter 62	18 AAC 62.010- 18 AAC 62.990	Sets standards for handling and disposal of hazardous waste	X		X	POTENTIALLY SELECTED-May be applicable for certain remedial actions.
Water Quality Standards (WQS) Chapter 70	18 AAC 70.010- 18 AAC 70.910	Sets standards for water quality	X		X	SELECTED-Water Quality Standards will regulate sites at Kotzebue LRRS.
WQS	18 AAC 70.020	Sets standards for the control of toxic wastes into fresh and marine waters			X	SELECTED-Criteria will apply to sites at Kotzebue LRRS.
WQS	18 AAC 70.022 (Proposed revision)	Set water quality criteria for carcinogenic substances for the protection of human health			X	POTENTIALLY SELECTED-May be applicable for risk assessment.
WQS	18 AAC 70.025	Modification of water quality standards based on site specific criteria			X	POTENTIALLY SELECTED-May be applicable based on conditions characterized at Kotzebue LRRS.
Oil and Hazardous Substances Pollution Control (OHPC) Chapter 75	18 AAC 75.010- 18 AAC 75.990	Sets regulations for oil and hazardous substances pollution control	X	X	X	SELECTED-Applicable for remediation of sites.
OHPC 18 AAC75.140	Interim guidance for non-UST petroleum contaminated soils	General guidelines establishing cleanup levels for petroleum hydrocarbon spills		X	X	EXCLUDED-ADEC indicates not applicable at Kotzebue LRRS.
OHPC 18 AAC 75.140	Guidance for storage, remediation, and disposal of non-UST petroleum contaminated soils	Comprehensive guidance for the storage, treatment, and disposal of non-UST petroleum contaminated soil			X	POTENTIALLY SELECTED-May be applicable for remediation of petroleum contaminated sites at Kotzebue LRRS.

TABLE 2-5. PRELIMINARY IDENTIFICATION OF STATE APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARS) FOR KOTZEBUE LRRS IRP REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROGRAM (Page 2 of 2)

Title 18. Environmental Conservation	State Regulation	Description	Chemical Specific	Location Specific	Action Specific*	Preliminary Rationale for Selection or Exclusion
OHPC 18 AAC 75.140	Interim guidance for surface and groundwater cleanup levels	Sets cleanup standards for contaminated surface soils and groundwater remediation			X	POTENTIALLY SELECTED-May be applicable for developing cleanup standards.
OHPC	18 AAC 75.300	Discharge notification requirement for discharge of any hazardous substances			X	POTENTIALLY SELECTED-If hazardous substances are identified discharging to surface water bodies (including Kotzebue Sound).
OHPC	18 AAC 75.319	Disposal approval of hazardous substances			X	POTENTIALLY SELECTED-Applicable for the disposal of certain hazardous substances.
OHPC	18 AAC 75.327	Requirements for containment, cleanup, and disposal of hazardous substances discharged into the environment			X	POTENTIALLY SELECTED-May be applicable for the remediation of sites.
Drinking Water Chapter 80	18 AAC 80.010- 18 AAC 80.900	Sets standards for Drinking Water	X	X	X	EXCLUDED-There are no drinking water sources within 3 miles of the installation. Near-beach groundwater is non-potable (brakish).

* Selection/Exclusion rationale is dependent on future actions.

- Migratory Bird Treaty Act of 1972
- Marine Mammal Protection Act
- Fish And Wildlife Conservation Act of 1980
- National Historical Preservation Act

Alaska State Regulations

- Air Quality Control (AQC)
- Solid Waste Management (SWM)
- Hazardous Waste (HW)
- Water Quality Standards (WQS)
- Oil and Hazardous Substances Pollution Control (OHSPO)
- Interim Guidance for Non-UST Petroleum Contaminated Soils
- Guidance for Storage, Remediation, and Disposal of Non-UST petroleum Contaminated Soils
- Interim Guidance for Surface and Groundwater Cleanup Levels

The ARARs listed in Tables 2-4 and 2-5 represent a thorough search of federal and state regulations for applicable or relevant and appropriate requirements. All identified ARARs are arranged into two tables (Tables 2-4 and 2-5) corresponding to federal and state regulations, respectively. Each table is arranged as follows: in the first column, the appropriate federal or state statue is listed, with subsequent listings of the statute given as abbreviations; in the second and third columns, the corresponding regulations are cited as provided by regulatory agencies, and a brief description of each regulation is given. ARARs were cross-checked with listings of federal and state regulations to ensure correct citations. In some cases, the statute is repeated several times as different sections of the regulations are discussed. The next three columns identify if the ARAR is chemical-, location-, or action-specific. The final column of the table presents a preliminary rationale for the selection or exclusion of the ARAR in regards to the activities to be performed during the remedial investigation/feasibility study or follow-on remedial activities.

Certain ARARs are listed as potentially selected because they are action-specific, and are subject to decisions to be made at a later stage in the RI/FS process or site cleanup. The rationale for the selection

or exclusion of an ARAR at this stage in the RI/FS is preliminary only, and is intended to provide a broad framework for initial discussions between the Air Force and regulatory agencies, and to assist in focusing negotiations leading to the final selection of ARARs for the Kotzebue LRRS RI/FS. This preliminary ARAR list will be refined during the RI/FS; once remedial actions are proposed, applicable action-specific ARARs will be determined.

2.4.3 State Regulation at Kotzebue LRRS

The Alaska Department of Environmental Conservation considers sites at Kotzebue LRRS under the Water Quality Standards Regulation (18 AAC 70; December 1989), based on surface water occurrence and TPH contamination of near-beach groundwater adjacent to Kotzebue Sound. Table 2-6 provides a description of the major water quality criteria that could impact site characterization and remedial actions conducted at Kotzebue LRRS, and includes sediment criteria, toxic and other deleterious organic and inorganic substances, and petroleum hydrocarbons, oils, and grease criteria.

ADEC has indicated that the use of Interim Guidance for Non-UST Contaminated Soil Cleanup Levels, dated July 17, 1991, is not applicable for developing soil cleanup levels at petroleum contaminated sites at Kotzebue LRRS due to the occurrence and potential for petroleum hydrocarbon migration to surface water and near-beach groundwater at the facility. However, ADEC has established a target level for diesel-range TPH at 1,000 mg/kg for the definition of lateral and vertical extent of petroleum hydrocarbon contaminated soils associated with the tundra hill and surrounding area.

2.5 DATA NEEDS

This section provides a summary of identified data needs to support site characterization, better define ARARs, perform an analysis of alternatives, and complete the site conceptual model. Data needs were identified based on the integration of available site information presented in Section 2.3, Site Conceptual Model. Site-specific data needs are presented by media in Table 2-7. In addition to sites described in Section 2.3, ten areas of concern were identified during the 1993 site survey. Remedial investigation objectives and activities for newly identified areas of concern are presented in Section 3.2.1.2, Areas of Concern, and support overall project objective data needs. The general project objective data needs to

TABLE 2-6. ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVA[illegible] WATER QUALITY STANDARD REGULATIONS (18 AAC 70, DECEMBER 1989)
(WATER QUALITY STANDARDS MOST PERTINENT TO KOTZEBUE LRRS, ALASKA)

Marine and Freshwater Use	Principal Water Quality Criteria for Kotzebue LRRS		
	Sediment	Toxic and Other Deleterious Organic and Inorganic Substances	Petroleum Hydrocarbons Oils and Greases
Marine and Freshwater Supply (Aquaculture)	No imposed loads that will interfere with established water supply treatment levels.	Substances shall not individually or in combination exceed 0.01 times the lowest measured 96-hour LC_{50} for life stages of species identified by the department as being the most sensitive, biologically important to the location, or exceed criteria cited in EPA Quality Criteria for Water, whichever concentration is less. Substances shall not be present or exceed concentrations which individually or in combination impart undesirable odor or taste to fish or other aquatic organisms, as determined by either bioassay or organoleptic test.	Shall not exceed 0.01 times the continuous flow 96-hour LC_{50} or, if not available, the static test 96-hour LC_{50} for the species involved.
Marine Water Supply (Seafood Processing)	Below normally detectable amounts.	Substances shall not exceed EPA Quality Criteria for Water as applicable to the substance.	Shall not cause a film, sheen, or discoloration on the surface or floor of the waterbody or adjoining shorelines. Surface waters shall be virtually free from floating oils. Shall not exceed concentrations which individually or in combination impart odor or taste, as determined by organoleptic tests.
Marine and Freshwater Supply (Industrial)	No imposed loads that will interfere with established water supply treatment levels.	Substances shall not be present which pose hazards to work contact.	Shall not make the water unfit or unsafe for the use.
Marine and Freshwater Recreation (Contact Recreation)	No measurable increase in concentrations above natural conditions.	Substances shall not exceed EPA Quality Criteria for Water as applicable to constituent.	Shall not cause a film, sheen, or discoloration on the surface or floor of the waterbody or adjoining shorelines. Surface waters shall be virtually free from floating oils.
Marine and Freshwater Recreation (Secondary Recreation)	Shall not pose hazards to incidental human contact or cause interference with the use.	Substances shall not be present which pose hazards to incidental human contact.	Shall not cause a film, sheen, or discoloration on the surface or floor of the waterbody or adjoining shorelines. Surface waters shall be virtually free from floating oils.
Marine and Freshwater (Growth and Propagation of Fish, Shellfish, Aquatic Life, and Wildlife)	No measurable increase in concentration above natural conditions.	Substances shall not individually or in combination exceed 0.01 times the lowest measured 96-hour LC_{50} for life stages of species identified by the department as being the most sensitive, biologically important to the location, or exceed criteria cited in EPA Quality Criteria for Water, whichever concentration is less. Substances shall not be present or exceed concentrations which individually or in combination impart undesirable odor or taste to fish or other aquatic organisms, as determined by either bioassay or organoleptic test.	Total hydrocarbons in the water column shall not exceed 15 ug/L or 0.01 of the lowest measured continuous flow 96-hour LC_{50} for life stages of species identified by the department as the most sensitive, biologically important species in a particular location, whichever concentration is less. Total aromatic hydrocarbons in the water column shall not exceed 10 ug/L, or 0.01 of the lowest measured continuous flow 96-hour LC_{50} for life stages of species identified by the department as the most sensitive, biologically important species in a particular location, whichever concentration is less. There shall be no concentrations of hydrocarbons, animal fats, or vegetable oils in the sediment which cause deleterious effects to aquatic life. Surface waters and adjoining shorelines shall be virtually free from floating oil, film, sheen, or discoloration.
Marine Water (Harvesting for Consumption of Raw Mollusks or Other Raw Aquatic Life)	Not applicable.	Substances shall not individually or in combination exceed 0.01 times the lowest measured 96-hour LC_{50} for life stages of species identified by the department as being the most sensitive, biologically important to the location, or exceed criteria cited in EPA Quality Criteria for Water, whichever concentration is less. Substances shall not be present or exceed concentrations which individually or in combination impart undesirable odor or taste to fish or other aquatic organisms, as determined by either bioassay or organoleptic test.	Shall not exceed concentration which individually or in combination impart undesirable odor or taste to organisms as determined by bioassay and/or organoleptic tests.

TABLE 2-7. GENERAL DATA NEEDS

Site Identification	Media	General Data Needs	Relevant Project Objectives			
			Risk Assessment	Natural Biodegradation	ARARs	Analysis of Alternatives
SS02-Waste Accumulation Area No. 2/Landfill	Soil	- Characterize soils and assess potential contamination	X		X	
		- Determine if buried wastes are present	X		X	X
	Groundwater	- Characterize groundwater quality and evaluate potential contaminant migration	X		X	
ST05-Beach Tanks	Soil	- Determine magnitude and extent of petroleum hydrocarbon contamination	X		X	X
		- Geotechnical information	X			X
	Groundwater	- Determine magnitude and extent of petroleum hydrocarbon contamination	X		X	X
		- Determine potential for natural biodegradation	X	X	X	X
SS07-Lake	Soil	- Determine potential contaminant migration source	X		X	
	Sediment	- Determine magnitude and extent of contamination	X		X	
	Surface Water	- Characterize surface water quality	X		X	
SS08-Barracks Pad	Soil/Fill	- Determine magnitude and extent of contamination	X		X	
SS11-Fuel Spill	Soil/Fill	- Determine magnitude and extent of contamination	X		X	
SS12-Spills No. 2 and 3	Soil (Native & Fill)	- Determine magnitude and extent of contamination	X		X	X
		- Delineation of contaminant source area(s)	X		X	X
		- Determine potential for natural biodegradation	X	X	X	X
	Surface Water	- Characterize surface water quality	X		X	
		- Characterize geochemistry		X		
A0C1-Landfarm	Soil/Fill	- Determine current levels of contamination in landfarm soils	X		X	X

be addressed during the remedial investigation at Kotzebue LRRS are summarized in the following sections.

2.5.1 Risk Assessment

In order to characterize the potential risks associated with Kotzebue LRRS sites, certain aspects of site characterization will be expanded, including:

- **Background Characterization**--Background characterization will be established through the collection of sufficient background samples for each analysis employed and media investigated.

- **Chemical Speciation**--Volatile and semivolatile analyses will be incorporated at sites previously characterized primarily by TPH measurements, and at newly identified areas of concern, to specifically evaluate individual toxicants associated with petroleum hydrocarbon contamination.

- **Ecological Receptors**--Ecological receptors, such as those associated with lake and beach environments, will be identified by a review of the literature and using information obtained from the U.S. Fish and Wildlife Service. Other ecological receptors of potential importance regarding human health risks associated with subsistence and recreational uses will also be identified using literature reviews and local sources of information.

- **Fate and Transport**--The three primary lithologies that characterize the Kotzebue LRRS include beach sands and gravels, native soils associated with the tundra hill and surrounding area, and fill material used for roads and facility foundations. Geotechnical samples (e.g., for permeability and grain size distribution analyses) will be collected from each lithology to support contaminant migration assessments. In addition to geotechnical information, total organic carbon (TOC) will be measured in soils to evaluate the potential for contaminant sorption within specific lithologies.

  Near-beach aquifer parameters, including vertical and horizontal hydraulic gradients, groundwater flow rate and direction, and hydraulic conductivity will be measured.

Hydraulic gradients and groundwater flow direction will be determined using water level measurements in monitoring wells. Hydraulic conductivity will be estimated by conducting falling and rising head slug tests in selected monitoring wells, and will also be calculated using aquifer tidal response monitoring data to provide estimates of transmissivity as a cross-check. Groundwater flow rates will be established based on hydraulic gradient measurements and hydraulic conductivity estimates.

Tidal monitoring will be conducted in monitoring wells installed at the ST05-Beach Tanks Site to determine the magnitude and extent of tidal influences on the local near-beach groundwater system.

2.5.2 Natural Biodegradation Assessment

Data will be obtained to specifically address whether natural biodegradation is active, and to what extent natural biodegradation may be responsible for the reduction of petroleum hydrocarbon contaminant concentrations in specific media and environments at Kotzebue LRRS. Geochemical parameters will be measured in surface waters and groundwaters both upgradient and downgradient of known source areas to document the relationship between aqueous geochemistry and contaminant chemistry, allowing an evaluation of the effect of natural biodegradation on these two impacted media at two known source areas, the ST05-Beach Tanks Site (groundwater) and the SS12-Spills No. 2 and 3 Site (surface water). Additionally, the rate of natural degradation of diesel fuel contamination in soils at Sites ST05 and SS12 will be assessed, evaluating the difference in composition between fresh and degraded diesel fuel by comparing carbon chain ratios of alkanes to isoprenoids. Additional information regarding geochemical analyses to evaluate natural biodegradation is included in Section 3.2.1.2.

2.5.3 Applicable or Relevant and Appropriate Requirements (ARARs)

A preliminary summary of potential ARARs is presented in Section 2.5, Applicable or Relevant and Appropriate Requirements. The preliminary identification of ARARs addressing chemical-specific requirements have been based on reported detections of contaminants during previous IRP investigations. Additional site characterization information, including current maximum contaminant concentrations, will be used to further refine the list of potential ARARs.

2.5.4 Analysis of Alternatives

A previous IRP feasibility study conducted for Kotzebue LRRS included a recommendation for *in situ* bioremediation of near-beach groundwater at Site ST05-Beach Tanks (see Table 1-4). Additionally, it was recommended that a bench-scale treatability test be conducted to further evaluate the *in situ* bioremediation alternative. The natural biodegradation assessment proposed for the near-beach groundwater system at Site ST05-Beach Tanks will provide necessary information to evaluate if *in situ* bioremediation is a viable alternative.

3.0 REMEDIAL INVESTIGATION/FEASIBILITY STUDY TASKS

This section describes the remedial investigation/feasibility study tasks that will be performed at Kotzebue LRRS. A detailed discussion describing how specific activities and field tasks will be accomplished (e.g., sample location identification and sampling methodology) is presented in the Field Sampling Plan (FSP) portion of the companion Sampling and Analysis Plan (SAP).

3.1 SITE OBJECTIVES

Tetra Tech's general approach regarding development of the Kotzebue IRP RI/FS is to maximize the use of existing data from previous site investigations. The overall site objectives include the collection of all data needed to characterize the site, support the natural biodegradation assessment, complete the site conceptual model, support the baseline risk assessment, better define ARARs, and perform an analysis of alternatives. A detailed discussion regarding project data needs is provided in Section 2.6, Data Needs. General site objectives based on identified data needs include the following:

- Background concentrations will be established through the collection of background samples for each analysis conducted and media investigated. No background samples were collected for soil, surface water, or groundwater characterization during previous IRP investigations conducted at Kotzebue LRRS.

- Determine the nature, magnitude, and extent of environmental contamination in soil, surface water, and groundwater media at Kotzebue LRRS.

- Collect the data needed to adequately characterize contaminant fate and transport at Kotzebue LRRS.

- Petroleum hydrocarbon contamination linked to past installation operations and activities at Kotzebue LRRS is primarily related to release(s) of middle-distillate fuels such as diesel and jet fuel. Petroleum hydrocarbon contamination was previously characterized by measuring residual range TPH using EPA Method 418.1. TPH characterization to be conducted at Kotzebue LRRS will be measured using diesel range TPH analyses (Method AK102) to provide a quantifiable method of determining the magnitude and extent of individual toxicants comprising total petroleum hydrocarbons at the installation.

- The TPH soil cleanup levels developed and implemented to guide site characterization and remedial action during previous IRP RI/FS activities are not acceptable to ADEC. TPH concentrations remaining in soils at selected sites will require additional characterization to evaluate current site conditions and the extent of potential contamination relative to ADEC accepted criteria. ADEC has established a TPH concentration of 1,000 mg/kg diesel range TPH in soils at Kotzebue LRRS for the characterization of sites located above the beach area.

- Routine analysis of volatile or semivolatile organic compounds was not performed during previous IRP investigations, thwarting a quantitative assessment of potential human or ecological risks. Additional site characterization will incorporate VOC and SVOC analyses to provide a basis for evaluating site risks associated with specific toxicants, and to support further assessment of suitable ARARs.

- The extent to which natural biodegradation may be active, and to what extent it may be responsible for a reduction in contaminant concentrations in groundwater, surface water, and soils will be evaluated.

- Ten new areas of concern have been identified in addition to the seven sites characterized during previous IRP investigations conducted at Kotzebue LRRS. The recently identified areas of concern will be characterized during the field investigation, and will incorporate site survey and historical information regarding past site use.

3.2 FIELD INVESTIGATION

The field investigation activities described in the following sections are proposed to meet project and site objectives, and are based on a review of past IRP investigation activities, site survey information, a background literature search, and the development of the Kotzebue LRRS site conceptual model. All field investigation activities and methodology will conform to the guidelines established by the *IRP Handbook*.

3.2.1 Field and Sample Analysis Activities Summary

This section provides a summary of field and sample analysis activities to be conducted at Kotzebue LRRS during the 1994 field season. The proposed locations and numbers of samples to be collected are estimates based on identified data needs for Kotzebue LRRS and a review of previous IRP investigation site survey results. The proposed site-specific sample locations and numbers of samples collected may vary based on field conditions encountered during the field investigation. Site-specific field and sample analysis activities are discussed in Section 3.2.2.

3.2.1.1 Field Activities Summary. Six sites identified during previous IRP field investigations have been selected for further characterization. The sites were selected based on a review of historical site information, previous IRP RI/FS results, ADEC correspondence concerning current site conditions, and site survey information. The six sites include: 1) Site SS02-Waste Accumulation Area No.2/Landfill; 2) Site ST05-Beach Tanks; 3) Site SS07-Lake; 4) Site SS08-Barracks Pad; 5) Site SS11-Fuel Spill; and 6) Site SS12-Spills No. 2 and 3. During September 1993, Tetra Tech and Air Force personnel conducted a site survey of the Kotzebue LRRS and surrounding areas. Ten areas of concern (AOCs) were identified during the site survey that warrant further consideration during this RI/FS field sampling effort. Figure 3-1 identifies sites and areas of concern (AOCs) to be investigated at Kotzebue LRRS. A summary of proposed field activities for Kotzebue LRRS is provided in Table 3-1.

3.2.1.2 Sample Analysis Activities Summary. The proposed sample analysis activities will be used to determine the nature, magnitude, and extent of contamination at sites, specifically address whether natural biodegradation is actively occurring at sites, and support a contaminant fate and transport assessment.

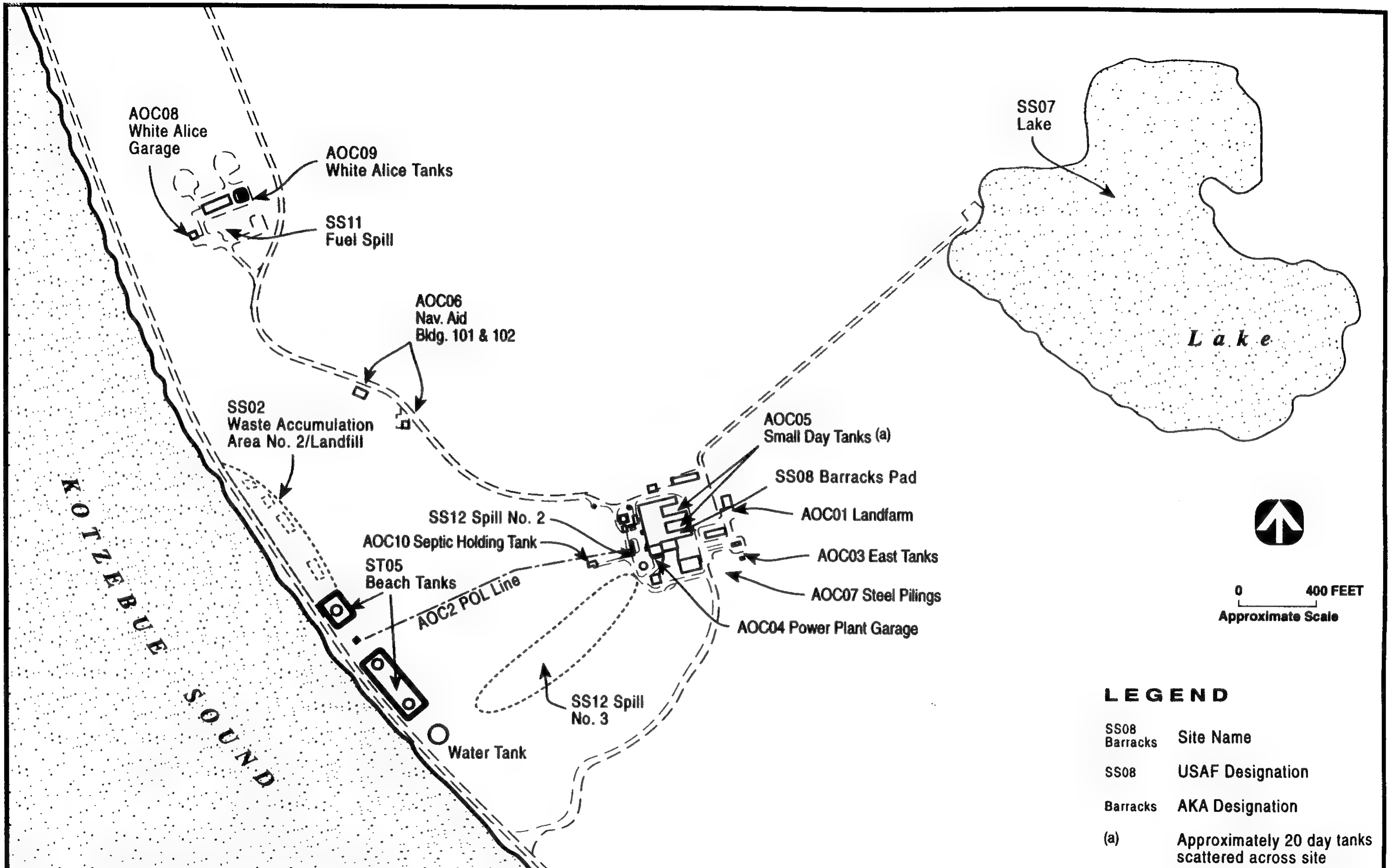

Figure 3-1. Areas of Investigation, Kotzebue LRRS, Alaska.

TABLE 3-1. SUMMARY OF PROPOSED FIELD ACTIVITIES FOR KOTZEBUE LRRS, ALASKA

Site Designation	Facilities Inspection	Field Screening	Hand Auger Sampling	Drilling and Sampling	Installing Wells	Groundwater Sampling	Surface Water Sampling	Seawater Sampling	Free Product Assessment	Tidal Influence	Aquifer Testing	Geotechnical Parameters	Gradiometer Survey	Sample Location Surveying
SS02-Waste Area No. 2/Landfill		X		X	X	X							X	X
ST05-Beach Tanks		X		X	X	X		X	X	X	X	X		X
SS07-Lake		X	X				X							X
SS08-Barracks Pad		X	X									X		X
SS11-Fuel Spill		X	X									X		X
SS12-Spills No. 2 and 3		X	X	X	X	X	X		X			X		X
AOC-1 Landfarm Landfarm Seeps		X X	X X											X X
AOC-2 POL Lines		X	X											X
AOC-3 East Tanks		X	X											X
AOC-4 Power Plant Garage	X	X	X											X
AOC-5 Small Day Tanks		X	X											X
AOC-6 Nav. Aid Bldg.	X	X	X											X
AOC-7 Steel Pilings	X	X	X											X
AOC-8 White Alice Garage	X	X	X											X
AOC-9 White Alice Tanks		X	X											X
AOC-10 Septic Holding Tank	X	X												X
Background Characterization		X	X	X	X	X	X	X						X

This section discusses general analyte selection, and provides a summary of proposed analyses in support of the contaminant, natural biodegradation, and fate and transport assessments. A detailed description of each analytical method to be conducted at Kotzebue LRRS is provided in the QAPP portion of the SAP.

<u>Contaminant Assessment</u>

Proposed sample analyses for existing sites and newly identified areas of concern are summarized in Table 3-2, including the estimated number of samples for each media, sample type, and the number of analyses and analytical methods for each sample, and the estimated distribution of quality assurance/quality control (QA/QC) samples. Analyte selection for Kotzebue LRRS sites was based on a review of previous IRP site characterization information and on the identification of additional data needed to support baseline risk assessment and other tasks. Analyte selection for areas of concern is based on suspected and potential hazardous substance(s) associated with the historical area use and/or operations at each AOC. A brief discussion regarding the rationale behind selection of analytical methods is provided.

Residual Range TPH (Method AK102-Extended)--TPH was characterized during previous IRP investigations by measuring residual range TPH using EPA Method 418.1. No background concentrations were established for the media sampled in the various sites. Due to the naturally high organic content of soils in arctic tundra environments, previous detections of residual range TPH do not necessarily define diesel range contamination at Kotzebue LRRS sites. Petroleum hydrocarbon contamination linked to past installation operations and activities is documented by releases of middle distillates (primarily diesel fuel and jet fuels). For this reason, TPH characterization at Kotzebue LRRS will be conducted by measuring diesel-range TPH, providing a quantifiable method of determining the extent of petroleum contamination at identified sites. However, limited sample analyses extending Method AK102 through C_{40} will be conducted to measure residual range hydrocarbons in soils at sites where waste oils are potentially present (e.g., SS02-Waste Accumulation Area No. 2/Landfill Sites, AOC1-Landfarm, AOC4-Power Plant/Garage, and AOC8-White Alice Garage AOCs).

TABLE 3-2. PROPOSED FIELD SAMPLING AND ANALYSES SUMMARY
KOTZEBUE LRRS, ALASKA

Site Designation	Media	Number of Samples	Proposed Analyses: TPH Residual Range (AK102 Extended)	TPH Gasoline Range (AK101)	TPH Diesel Range (AK102)	VOC (8260)	SVOC (8270)	PCB (8081)	Pesticides (8081)	Metals[a] (6000, 7000)
SS02-Waste Area No. 2/ Landfill	Soil Groundwater	3 3	TBD[b]		3 3	3 3	3 3	3 3	3 3	3 6
ST05-Beach Tanks	Sediment Groundwater Seawater	20 15 3	TBD		20 15 3	10 15 3	10 15 3		3	
SS07-Lake	Sediment Surface Water	3 3			3 3	1 1	3 3	3 3	3 3	3 2
Lake Access	Soil	2						2	2	
SS08-Barracks Pad	Soil	4 to 8			4 to 8	3 to 5	3 to 5		3	2
SS11-Fuel Spill	Soil	5			5	5	5		5	
SS12-Spills No. 2 and 3	Soil Groundwater Surface Water	30 1 3			30 1 3	10 1 3	10 1 3		10 1 3	
AOC1-Landfarm	Soil	6	TBD		6	3	3		3	2
Landfarm Seeps	Soil	4 to 8			4 to 8	4 to 8	4 to 8		4	2
AOC2-POL Lines	Soil	3 to 8			3 to 8	3 to 8	3 to 8		3	
AOC3-East Tanks	Soil	3 to 6			3 to 6	3 to 6	3 to 6		3	
AOC4-Power Plant/Garage	Soil	4 to 8	TBD	4 to 8	4 to 8	4 to 8	4 to 8	4	4	2
AOC5-Small Day Tanks	Soil	12 to 20			12 to 20	12 to 20	12 to 20		12 to 20	
AOC6-Nav. Aid Building	Soil	3 to 6			3 to 6	3 to 6	3 to 6	3	3	2
AOC7-Steel Pilings	Soil	3 to 6			3 to 6	3 to 6	3 to 6	3	3	2
AOC8-White Alice Garage	Soil	3 to 6	TBD	3 to 6	3 to 6	3 to 6	3 to 6	3	3	2
AOC9-White Alice Tanks	Soil	3 to 6			3 to 6	3 to 6	3 to 6		3	
AOC10-Septic Holding Tank	Soil Sediment	0 to 3 1			0 to 3 1	0 to 3 1	0 to 3 1	0 to 3 1	0 to 3 1	0 to 3 1
Background Characterization	Soil Lake Sediment Beach Sediment Groundwater Surface Water Sea Water	3 3 3 3 3 1	TBD	3	3 3 3 3 3 1	3 3 3 3 3 1	3 3 3 3 3 1	3 3 3 3 3	3 3 3 3 3	3 3 3 6 6
Total Number of Project Samples	Soil Sediment Groundwater Surface Water Seawater	89 to 134 30 22 9 4	TBD	10 to 17	89 to 132 30 22 9 4	65 to 106 18 22 7 4	65 to 106 20 22 4	21 to 24 10 6 6	67 to 78 13 7 9	20 to 23 10 12 8
QA/QC Samples	Trip Ambient Equipment Duplicate[c] •Soil/Sediment •Water	15 to 30 15 to 20 20 to 35 12 to 20 4		 5 to 10 1 to 2 	 20 to 35 12 to 19 4	15 to 30 15 to 20 20 to 35 8 to 13 3	 20 to 35 8 to 13 3	 20 to 35 3 to 5 2	 20 to 35 8 to 12 2	 20 to 35 3 to 6 3

[a] Metals analysis for water samples will include total and dissolved.
[b] TBD = To Be Determined (residual range organics to be evaluated based on AK102 analytical results revealing the presence of heavier end hydrocarbons).
[c] Duplicate samples collected at 10 percent frequency.

Gasoline Range TPH (Method AK101)--The past use of gasoline fuels at Kotzebue LRRS has not been documented, and no information regarding potential releases of gasoline fuels has been reported at Kotzebue LRRS. However, gasoline-range TPH analyses will be conducted at garage locations (AOC4-Power Plant/Garage and AOC8-White Alice Garage) where vehicle storage and maintenance occurred in the past. Additionally, gasoline-range TPH analyses will be conducted on a site-specific basis if potential gasoline source(s) are identified or suspected.

Diesel Range TPH (Method AK102)--Diesel range TPH analyses using Method AK102 has been selected to characterize petroleum hydrocarbon contamination at most Kotzebue LRRS sites and AOCs. Diesel-range TPH analyses will provide the most appropriate and quantifiable method for determining the magnitude and extent of TPH contamination at the facility.

Volatile Organic Compounds (EPA Method 8260)--VOC analyses using U.S. EPA Method 8260 has been selected to characterize volatile organic contaminants at sites and AOCs. VOC analyses will be conducted routinely to measure volatile organic compounds associated with petroleum hydrocarbon contamination, and to evaluate other potential contaminant sources (e.g., waste oils and solvents).

Semivolatile Organic Compounds (SVOCs; by EPA Method 8270)--Only limited SVOC analyses were conducted during previous IRP investigations at Kotzebue LRRS. The primary source of petroleum hydrocarbon contamination is related to middle-distillate fuels (diesel and jet fuels), which contain approximately 10 weight percent polynuclear aromatic hydrocarbons. Additionally, waste oils and solvents stored and used at the installation may be an SVOC source at some sites or AOCs. The analysis of SVOCs by Method 8270 will be routinely conducted to characterize a wide range of semivolatile compounds potentially present at Kotzebue LRRS sites and AOCs.

Organochlorine Pesticides and PCBs (EPA Method 8081)--Pesticides may have been used to control insects at the installation (no documented use). Organochlorine pesticides, including 4,4'-DDT, have been detected at relatively low concentrations at a number of sites previously investigated at Kotzebue LRRS, and will therefore be routinely analyzed for in samples collected during the site investigation. The PCB Aroclor 1260 has been detected in soils at the White Alice Station and in a sediment sample collected from the former water supply lake. PCB contaminated soils at the White Alice Station have been excavated and removed during previous IRP remedial actions. PCBs analyses to be conducted

in support of further installation characterization include the sampling of sediments in the former installation water supply lake (Site SS07), and of soils at locations not previously characterized where waste oils may be present.

Metals (EPA 6000, 7000 Series)--Metals analyses have been conducted at a limited number of sites during previous IRP investigation including soils at the SD03-Road Oiling and SS01-Waste Accumulation Area No. 1 Sites, and surface water at Site SS07-Lake. Detected metals concentrations are reportedly within the normal range found in the contiguous United States. However, no background concentrations have been established. Metals analyses have been proposed for selected sites and areas of concern based on the past use of waste oils and/or spent solvents at select locations.

Natural Biodegradation Assessment

A suite of geochemical parameters are scheduled for the analysis of water samples collected at two sites at Kotzebue LRRS, groundwater at the ST05 Beach Tanks Site, and surface water at the SS12 Spills No. 2 and 3 Site. Sampling at both sites will include a minimum of three samples collected along a flow path, comprised of both upgradient and downgradient samples, with both proximal and distal downgradient samples collected and analyzed. At the Beach Tanks Site, dual completion monitoring wells will be used to also evaluate geochemical and contaminant trends vertically in the upper portion of the aquifer.

Table 3-3 presents the geochemical analytical suite proposed for this portion of the RI/FS field investigation. The table includes several parameters that will be measured in the field using either portable instrumentation (e.g. pH, DO, etc.), or field test kit analyses (CO_2, chloride, alkalinity, etc.). The analyte list has been adapted from a draft technical protocol developed by AFCEE for the evaluation of natural biodegradation at sites contaminated with petroleum hydrocarbons (Wiedemeier et al. 1994).

Biodegradation will be evaluated at a site by evaluating the aqueous geochemistry at the upgradient end of a flowpath, and comparing the geochemical and contaminant chemistry at downgradient locations along that flowpath. This will elucidate chemical trends that are attributable to the anaerobic and aerobic biodegradation of petroleum hydrocarbons occurring in the subsurface environment at a given site. At sites where natural biodegradation is occurring, one would expect to observe a decrease in the concentration of compounds that act as a food source (e.g. dissolved oxygen, nitrate, sulphate) to the bacteria

TABLE 3-3. PROPOSED FIELD SAMPLING AND ANALYSES SUMMARY
FOR GEOCHEMICAL PARAMETERS
KOTZEBUE LRRS, ALASKA

Proposed Analyses	Site Designation			
	ST05-Beach Tanks	SS12-Spills No. 2 and 3		Background
Media	Groundwater	Surface Water	Groundwater	Surface Water
Alkalinity (Field Test)	12	3	1	1
Ammonia (Field Test)	12	3	1	1
Chloride (Field Test)	12	3	1	1
Carbon Dioxide (Field Test)	12	3	1	1
Nitrate (Field Test)	12	3	1	1
Phosphate (Field Test)	12	3	1	1
Sulfate (Field Test)	12	3	1	1
Sulfide (Field Test)	12	3	1	1
Total Metals Fe/Na/Ca/K/Mg (EPA Method 6010)	12	3	1	1
Total Organic Carbon (EPA Method 9060)	12	3	1	1
pH (Field Measurement)	12	3	1	1
Temperature (Field Measurement)	12	3	1	1
Specific Conductivity (Field Measurement)	12	3	1	1
Dissolved Oxygen (Field Measurement)	12	3	1	1

responsible for biodegradation, an increase in the concentration of metabolic byproducts (e.g. CO_2), and changes in the concentration of other parameters that often accompany biodegradation (e.g., increase in the dissolved iron concentration). These trends will be compared to decreases in contaminant concentrations and changes in geochemical parameters to ascertain the degree to which natural biodegradation is proceeding in the subsurface, characterize the type of biodegradation that is occurring (aerobic, anaerobic), and define associated changes in aqueous geochemistry.

<u>Fate and Transport Assessment</u>

Three primary lithologies characterize the Kotzebue LRRS: beach sands and gravels, native soils associated with the tundra hill and surrounding area, and fill material used for roads and facility foundations. To support the contaminant migration assessment for each lithology, Tetra Tech proposes to collect up to three geotechnical samples from each lithology to evaluate physical properties, including permeability and grain size distribution. If a representative (undisturbed) sample cannot be obtained from the coarse beach sands and gravels, only grain size distribution samples will be collected for analysis. In addition to geotechnical information, three soil samples from each lithology will be collected for the analysis of total organic carbon (TOC) to evaluate the potential for contaminant sorption within specific lithologies. The following tests are proposed for geotechnical and TOC characterization:

		Number of Samples		
Test	Test Method	Beach Sands/Gravels	Tundra	Fill
Soil Permeability	Constant-head (ASTM Method D5084)	3	3	3
Grain Size Distribution	ASTM C136 and D422	3	3	3
Total Organic Carbon (soil)	EPA Method 9060	3	3	3

3.2.2 Site-Specific Field and Sample Analysis Activities

The following sections identify, describe, and provide general rationale for site-specific field and sample analysis activities to be conducted at Kotzebue LRRS. The specific details of how field tasks will be accomplished are described in the QAPP portion of the SAP.

3.2.2.1 Kotzebue LRRS Identified Sites. Six sites identified during previous IRP remedial investigations have been selected for further characterization including: 1) SS02-Waste Accumulation Area No.2/ Landfill, 2) ST05-Beach Tanks, 3) SS07-Lake, 4) SS08-Barracks pad, 5) SS11-Fuel Spill, and 6) SS12-Spills No. 2 and 3. A brief identification and description of Kotzebue LRRS sites are provided in Section 1.2.2, Previous Investigation Activities and Documentation. Figure 3-1 provides an installation diagram identifying the location of the six previously identified sites selected for characterization. Site investigation activities for these six sites are summarized in Table 3-1. A breakdown of samples to be collected and the corresponding analyses to be performed is presented in Table 3-2. The following section provides a more detailed description of field and sample analysis activities to be conducted at the six selected sites.

Site SS02 Waste Accumulation Area No.2/Landfill

No previous site characterization has been conducted at Waste Accumulation Area No. 2 and the installation landfill area (Site SS02). This site was recommended for no further action due to a lack of evidence regarding contamination and environmental stress during a previous IRP RI/FS 1987 field reconnaissance. However, some buried wastes reportedly remained within the former landfill area.

ADEC has provided correspondence requesting that a record review be conducted to determine the types of wastes buried at the landfill, estimate the quantity of waste, and establish the depth of buried wastes prior to consideration of a no further action alternative for this site. No additional site-specific waste management information was identified for the Site SS02 during a recent literature search and historical review. However, general information is available regarding typical wastes disposed of at similar LRRS facilities. During a site survey conducted in September 1993, Tetra Tech and Air Force personnel inspected the site and identified scattered areas of mounding that contain former landfill debris. It is currently suspected that the previously reported buried wastes comprise these mounded areas. The site is well vegetated, with no visual signs of soil staining, leaching, or stressed vegetation.

Tetra Tech proposes to investigate groundwater and soils based on the limited site-specific waste disposal information and general lack of environmental characterization information pertaining to Site SS02. Non-intrusive investigative techniques will be employed to characterize soil and groundwater quality associated with the site. Groundwater will be characterized between the site and Kotzebue Sound downgradient of

the mounded areas to evaluate potential contaminant migration to Kotzebue Sound. Surface soil samples will be collected from locations that exhibit signs of leaching or staining, at the base of waste mounds, and/or from areas that yield detections using field screening techniques (see Section 3.2.5). Additionally, Tetra Tech will determine the lateral extent of buried metallic debris present in the landfill by conducting a gradiometric survey of the area. A variety of wastes are suspected to have been stored and disposed of at this site, and field samples will be analyzed for a broad range of compounds.

Gradiometric Survey--Tetra Tech will conduct a gradiometric survey of the former landfill area using a Ferro-Trak FT-60 magnetic locator. The survey will map the lateral extent of buried metallic debris. The survey will be conducted by establishing a grid oriented parallel to the long axis of the landfill and using 25-foot spacings between instrument readings. The lateral extent of buried metal debris will be identified on a site plan together with instrument grid spacings, instrument readings, and field observations.

Soil Sampling--Three surface soil samples will be collected from locations within Site SS02 that exhibit leaching or staining, are located at the base of waste mounds, and/or from areas identified using field screening techniques. All samples will be analyzed for the following: diesel-range TPH using Method AK102, VOCs (EPA Method 8260), SVOCs (EPA Method 8270), pesticides and PCBs (EPA Method 8081), and total metals using the EPA Method 6000/7000 Series.

Groundwater Sampling--Three shallow groundwater monitoring wells will be installed in assumed downgradient locations between the site and Kotzebue Sound to evaluate potential contaminant migration via groundwater. All groundwater samples will be submitted for the following analyses: diesel-range TPH using Method AK102, VOCs using EPA Method 8260, SVOCs using EPA Method 8270, pesticides and PCBs using EPA Method 8081, and total and dissolved metals using the EPA Method 6000/7000 series).

Site ST05-Beach Tanks

The three above-ground fuel storage tanks formerly located adjacent to the beach were used to store arctic-grade diesel fuel to heat and power the station. Previous IRP investigations identified elevated

concentrations of residual petroleum hydrocarbons in subsoils and groundwater at the ST05-Beach Tanks Site. The lateral and vertical extent of groundwater contamination was not fully defined during previous site investigations. Additional site characterization is needed to evaluate current site conditions and to determine the nature and extent of petroleum hydrocarbon contamination.

Site characterization will incorporate the collection of subsoil samples, groundwater samples, seawater samples, and will include a survey for floating hydrocarbon product. In addition to contaminant characterization, geochemical parameters will be measured in groundwater to evaluate the extent to which natural biodegradation is active, and to determine the extent to which biodegradation may be responsible for the reduction of contaminant concentrations in groundwater.

Additional site characterization information to be collected in support of a contaminant fate and transport assessment of Site ST05 will include geotechnical parameters (e.g., permeability and grain size distribution), near-beach groundwater system characteristics (e.g., hydraulic gradients, flow direction and rate, and hydraulic conductivity), and an assessment of tidal influence on the shallow near-beach aquifer.

Previous IRP RI/FS activities have included a feasibility study identifying potential remedial alternatives for the ST05-Beach Tanks Site, including a recommendation that the *in situ* bioremediation of soils and groundwater be instituted. The natural biodegradation assessment to be conducted at Site ST05-Beach Tanks will provide the information necessary to evaluate the *in situ* bioremediation alternative. In addition to geochemical characterization, macronutrients (including nitrogen and phosphorus) will be measured in near-beach groundwater samples collected at Site ST05 to determine if nutrient concentrations are limiting natural biodegradation.

Subsoil Sampling--Tetra Tech proposes to advance 22 shallow soil borings in the vicinity of the former beach tanks. Sample locations are based on previously identified estimates of contamination extent and zones of maximum petroleum hydrocarbon concentration. The sample cores obtained during drilling will be screened for the presence of petroleum hydrocarbons using the field screening techniques described in Section 3.2.5, Field Screening Techniques. One subsoil sample will be submitted for laboratory analysis from each boring based on sample screening results. All subsoil samples will be

analyzed for TPH as diesel fuel (Method AK102). Additionally, ten samples will be submitted for VOCs (EPA Method 8260), and SVOCs (EPA Method 8270). Pesticides were not previously characterized at the site. Three samples will be submitted for pesticides using EPA Method 8081.

Groundwater Sampling--Shallow groundwater monitoring wells will be installed in nine of the 22 boreholes advanced at the ST05-Beach Tanks Site. Six additional wells will be installed at deeper depths to evaluate groundwater physical and chemical characteristics versus depth. The monitoring wells will be used to estimate the extent of potential groundwater contamination, provide representative and reproducible groundwater samples for aquifer characterization, and to evaluate the groundwater potentiometric surface. The construction of these monitoring wells will vary slightly from guidelines established for monitoring well construction in the *IRP Handbook*. The proposed variations are based upon conversations with drilling contractors experienced in monitoring well construction in arctic regions, and are detailed in the FSP portion of the SAP companion document. One groundwater sample will be collected from each monitoring well and submitted for laboratory analysis, including diesel-range TPH (Method AK102), VOCs (EPA Method 8260), and SVOCs (EPA Method 8270). Selected wells will also be sampled for geochemical and conventional parameters to support the natural biodegradation assessment for the site.

Seawater Sampling--Tetra Tech will collect three seawater samples from Kotzebue Sound to evaluate the affect of groundwater contaminants on the quality of seawater at the Beach Tanks Site. The samples will be collected below water surface from near-shore locations spaced along the beach adjacent to the former fuel storage tanks. The three samples will be analyzed for the presence of diesel-range TPH using Method AK102, VOCs (EPA Method 8260), and SVOCs (EPA Method 8270).

Assessment of Free Hydrocarbon Product--Previous IRP site characterization data indicate a maximum TPH concentration in groundwater in the beach tanks area of 8,700 mg/L, indicating a slight potential for the existence of free product or sheen on the water table. Each monitoring well will be investigated for the presence of free petroleum hydrocarbons no sooner than two days after the completion of well development. The presence and thickness of free hydrocarbon product will be determined and measured using an oil/water interface probe. If possible, any wells containing floating product will be sampled by removing a sample from the well using a top-filling stainless steel bailer. The thickness of

product measured using the interface probe, and any other information regarding the presence of free product in the wells, will be recorded in the field logbook.

Natural Biodegradation--A suite of geochemical parameters will be measured in groundwater samples obtained from monitoring wells located both upgradient and downgradient of the Beach Tanks pads (see Table 3-3). The relationship between groundwater geochemistry and contaminant chemistry as groundwater moves through this source area will allow a determination of the extent to which natural biodegradation may be active and to what extent it may be responsible for a reduction in contaminant concentrations in groundwater.

Tidal Monitoring--Previous IRP site characterization studies indicate that the near-beach groundwater system is influenced by tidal fluctuations in Kotzebue Sound. Mean tidal flux is approximately 2.1 ft, and diurnal tidal flux is approximately 2.7 ft for Kotzebue Sound (NOAA 1990). Tidal influences were not quantified relative to a common datum during previous investigations at Site ST05. The influence of tides on the aquifer system can directly affect hydraulic characteristics and geochemistry, influencing contaminant migration and impacting the evaluation of remedial alternatives. Tidal influences on the near-beach groundwater system will be electronically monitored for a 48-hour period to encompass four complete diurnal tide cycles. A data logger and pressure transducers will be installed in selected monitoring wells at shallow and intermediate depths. A surveyed stilling well will be installed in the fore-beach and instrumented with a data logger and transducer to provide baseline tidal data for comparison purposes. No tidal monitoring station is known to exist for Kotzebue Sound, requiring the collection of baseline data. Tidal monitoring will be conducted during a period of maximum tidal flux to the extent possible.

Aquifer Characterization--An aquifer test involving a pumping well and several observation wells was originally proposed by Tetra Tech to establish representative values for key aquifer characteristics in the Beach Tanks area. Because of the logistics involved with conducting such a test, as well as the treatment and disposal of the large volume or potentially contaminated groundwater that would be generated by an aquifer pump test, other test methods have been proposed. The slug tests described below will not provide data of the same type, representativeness, and quality as that obtained from a pumping test because the aquifer is not sufficiently stressed. However, the overriding advantage of slug

tests is that no contaminated groundwater is generated. To bolster the quality of the data obtained, duplicate measurements of key aquifer parameters will be made using the methods outlined below.

Slug tests will be conducted in the six intermediate-depth monitoring wells installed in the vicinity of the Beach Tanks Site to evaluate aquifer characteristics associated with the Kotzebue Sound beach area. The slug tests will consist of both rising-head and falling-head tests. The data will be analyzed using the Bower-Rice method for unconfined aquifers to provide estimates of hydraulic conductivity. The low magnitude of Kotzebue Sound tidal flux will not adversely effect the slug test results due the short duration of the slug tests relative to tide-induced water level changes.

Other near-beach aquifer parameters, including vertical and horizontal hydraulic gradients and groundwater flow rate and direction will also be measured. Both vertical and horizontal hydraulic gradients and groundwater flow directions will be determined using monitoring well water level measurements. Groundwater flow rates will be established based on hydraulic gradient measurements and hydraulic conductivity estimates. Hydraulic conductivity will also be calculated using aquifer tidal response monitoring data to provide estimates of transmissivity for comparison with the slug test results.

Geotechnical Parameters--Tetra Tech will collect subsoil samples for geotechnical testing to estimate critical parameters regarding contaminant transport through the subsurface in the vicinity of the STO5-Beach Tanks Site. Three locations have been identified for the collection of geotechnical samples, one each in the back-beach, mid-beach, and fore-beach areas. One sample will be collected from each location and submitted for grain-size analysis (ASTM Method C136 and D442), soil permeability testing (ASTM Method D5084), and total organic carbon (EPA Method 9060). Samples will be collected from the vadose zone just above the groundwater surface and from the saturated zone just below the groundwater surface. Sampling will be conducted in areas determined to be free of contamination by the field sampling team. The final determination of the three sampling locations will be made in the field. Shelby tubes will be used to collect undisturbed samples for permeability testing.

Site SS07-Lake

The former installation water supply lake is located approximately 0.25 miles northeast of the Composite Facility, and has been described as a receptor of spring breakup water. Previous IRP investigations have

included surface water and sediment sampling at a single location near the former water supply intake, with the subsequent detection of PCBs and pesticides in the lake sediment samples.

ADEC has requested that the source and extent of PCBs and pesticides detected in lake sediments be established. No documented use of pesticides has been identified at Kotzebue LRRS, but pesticides may have been used to control insects. Pesticides have been detected at relatively low concentrations at several locations at Kotzebue LRRS; however, the detection of PCBs at Kotzebue LRRS is limited to two locations at the White Alice Station. It is not likely that PCB contamination has migrated from the White Alice Station to the former water supply lake based on the relatively low mobility of PCBs in the environment and low permeability and high organic carbon content of native soils. Past waste management practices at Kotzebue LRRS include the use of waste oils for dust control along installation access roads. Previous site characterization of road oiling activities at the installation revealed no detections of PCBs. However, a road does exist between the main facility and the former water supply intake at the lake; this road could represent a potential source for the PCB contamination identified in lake sediments. Tetra Tech proposes to conduct characterization of the lake to verify the presence of previously identified contamination, evaluate the magnitude and extent of potential contamination (if present), and evaluate potential contaminant source area(s).

Sediment Sampling--Tetra Tech proposes to collect three sediment samples from the former water supply lake. One sample will be located at or near the original sample location to confirm the presence of previously detected contamination. Two additional samples will be collected to estimate the potential extent of contamination. All lake sediment samples will be analyzed for diesel-range TPH using Method AK102, SVOCs (EPA Method 8270), pesticides and PCBs (EPA Method 8081), and total metals (EPA Method 6000/7000 Series). One sediment sample will be analyzed for the presence of VOCs (EPA Method 8260).

Surface Water Sampling--Tetra Tech proposes to collect three surface water samples from the former water supply lake at locations similar to those selected for sediment sampling. Surface water samples will be collected prior to the collection of sediment samples to avoid the incorporation of disturbed sediment in water samples. All samples will be analyzed for the following: Diesel-range TPH

using Method AK102, SVOCs (EPA Method 8270), and pesticides and PCBs (EPA Method 8081). One water sample will be analyzed for the presence of VOCs (EPA Method 8260), and for both total and dissolved metals (EPA Method 6000/7000 series).

Soil Sampling--Tetra Tech proposes to collect two soil samples from the lake access road near the former water supply intake to evaluate the potential of road oiling as a source of lake sediment contamination. Samples will be selected based on screening techniques described in Section 3.2.5, Field Screening Techniques. Each sample will be analyzed for pesticides and PCBs using EPA Method 8081.

Site SS08-Barracks Pad

Previous field characterization at this site included the collection of five soil samples. The maximum detected contaminant concentrations include TPH at 5,960 mg/kg, and the pesticide 4,4'-DDD at 0.19 mg/kg. Previously developed soil cleanup levels developed to guide remedial assessment indicated that no further action was warranted at this site. ADEC has indicated that previously developed cleanup goals for TPH contaminated soils are not acceptable. A target cleanup level of 1,000 mg/kg for diesel-range TPH in soils has been established by ADEC for Kotzebue LRRS sites located above the beach area. Additional site characterization at Site SS08-Barracks Pad will be required to evaluate current site conditions and determine the extent of potential contamination.

Soil Sampling--Tetra Tech proposes to collect from four to eight near-surface soil samples in the vicinity of the barracks pad. Samples will be selected for analyses on the basis of field observations and sample screening procedures outlined in Section 3.2.5, Field Screening Techniques. All samples will be analyzed for diesel-range TPH using Method AK102. Three to five samples will be analyzed for VOCs using EPA Method 8260, SVOCs using EPA Method 8270, and for pesticides using EPA Method 8081. Two samples will be analyzed for total metals using the EPA Method 6000/7000 Series.

Geotechnical Parameters--Tetra Tech proposes to collect subsoil samples in engineered fill material and native tundra for geotechnical testing to estimate critical parameters regarding contaminant transport in the vicinity of Site SS08. One sample each will be collected from fill material and native tundra and submitted for grain-size analysis (ASTM Method C136 and D442), soil permeability testing (ASTM Method D5084), and analysis of total organic carbon (EPA Method 9060). Shelby tubes will be

used to collect undisturbed samples for permeability testing. Sampling will be conducted in areas determined to be free of contamination by the field team.

Site SS11-Fuel Spill

Previous characterization activities at this jet fuel spill site at the White Alice Station identified elevated concentrations of TPH in soils, with additional detections of toluene, total xylenes, and the pesticide 4,4'-DDT. Remedial actions conducted at the site involved the aeration of soils and enhanced *in situ* bioremediation, including areal application of emulsifiers and micronutrients. Although a mean reduction in TPH concentrations over time has been reported, current site conditions will be characterized and the extent of contamination will be evaluated.

Soil Sampling--Tetra Tech proposes to collect up to five hand-augered soil samples in the vicinity of the former jet fuel spill. Samples will be selected for analysis using field observations and sample screening procedures outlined in Section 3.2.5, Field Screening Techniques. All samples will be analyzed for diesel-range TPH using Method AK102, VOCs using EPA Method 8260, SVOCs using EPA Method 8270, and for pesticides using EPA Method 8081.

Geotechnical Parameters--Tetra Tech proposes to collect subsoil samples in engineered fill material and native tundra for geotechnical testing to estimate critical parameters regarding contaminant transport in the vicinity of Site SS11. One sample each will be collected from fill material and native tundra and submitted for grain-size analysis (ASTM Method C136 and D442), soil permeability testing (ASTM Method D5084), and analysis of total organic carbon (EPA Method 9060). Shelby tubes will be used to collect undisturbed samples for permeability testing. Sampling will be conducted in areas determined to be free of contamination by the field team.

Site SS12-Spills No. 2 and 3

Past diesel fuel spills have impacted an estimated 1.5 acre area adjacent to the Composite Facility. Previous IRP remedial investigations included limited soil sample collection and a soil gas survey. Soil sample analytical results identified elevated TPH concentrations, with additional detections of pesticides

and BETX compounds. The soil gas survey was conducted to determine the extent of petroleum hydrocarbon contamination. However, the soil gas survey data is reportedly non-quantifiable, primarily due to the extreme variability of soil moisture content.

Remedial actions conducted during previous IRP RI/FS activities at Site SS12 include limited soil excavations to remove TPH contaminated soils. However, structures in the vicinity of Spill No. 2 restrict the removal of contaminated soils, and diesel contamination remains in site soils at unknown concentrations. The limits of excavations at both Spill No. 2 and Spill No. 3 are not defined in associated IRP RI/FS reports, and no confirmation sampling has been conducted to verify the effectiveness of the removal. Enhanced *in situ* bioremediation activities have been conducted at Spill No. 3 in native tundra, including areal applications of emulsifiers and micronutrients. Additionally, treatment infiltration trenches were installed at the Spill No. 2 site where excavations could not proceed in an attempt to degrade TPH in soils surrounding pipes, pumps, tanks, and fencing.

Previous site investigations have not adequately characterized the vertical or lateral extent of petroleum hydrocarbon contamination at this site. ADEC has indicated that the extent of diesel fuel contamination should be identified prior to proceeding with remedial actions at the Spill No. 2 site. Interim remedial actions involving the removal of gravel fill source areas are being considered during the proposed site characterization. Additional site characterization objectives include the definition of suspected contaminant source areas in gravel fill materials, and characterization of the lateral and vertical extent of contamination. A suite of contaminant and geochemical parameters will be collected from active zone surface waters at Site SS12 in support of an evaluation of natural biodegradation.

Soil Sampling--Tetra Tech proposes to collect from 30 to 50 near-surface soil samples, with sample locations based on areal coverage and field screening techniques (see Section 3.2.5). General site topography slopes moderately to the west toward the Kotzebue Sound, and sample locations will be selected along drainage pathways to evaluate the lateral and downgradient extent of petroleum hydrocarbon contamination in the native tundra. Sampling will be conducted using a phased approach. Approximately thirty samples will be submitted for analysis initially, with remaining samples to be collected based on a review of the preliminary sample analytical results. All soil samples will be analyzed for diesel-range TPH using Method AK102. Ten soil samples will be selected for additional

analyses to evaluate individual toxicants, including VOCs using EPA Method 8260, SVOCs using EPA Method 8270, and pesticides using EPA Method 8081.

Surface Water Sampling--Three surface water samples will be collected where standing water is present downgradient of contaminant sources (e.g., former cut-off trench). Samples will be selected based on visual observations (e.g., presence of oil sheen) and using field screening techniques. Surface water samples will be analyzed for diesel-range TPH using Method AK102, VOCs using EPA Method 8260, SVOCs using EPA Method 8270, and for pesticides using EPA Method 8081. A suite of geochemical parameters will be measured in active zone surface waters samples both upgradient and downgradient of the Spills No. 2 and 3 source area. The relationship between surface water geochemistry and contaminant chemistry as surface water moves through this area will allow a determination of the extent to which natural biodegradation may be active and to what extent natural biodegradation may be responsible for a reduction of contaminant concentrations in surface water.

Groundwater Sampling--One groundwater sample will be collected from a monitoring well installed at the base of the tundra hill, where site drainage features converge. The groundwater sample will be evaluated to determine if site drainage features provide a pathway for contaminant transport to the near-beach groundwater system, which ultimately discharges into Kotzebue Sound. The groundwater sample will be analyzed for diesel-range TPH using Method AK102, VOCs using EPA Method 8260, SVOCs using EPA Method 8270, and for pesticides using EPA Method 8081. Groundwater will also be sampled for geochemical and conventional parameters to support the natural biodegradation assessment at Site SS12.

Geotechnical Sampling--Tetra Tech proposes to collect subsoil samples in engineered fill material and native tundra for geotechnical testing to estimate critical parameters regarding contaminant transport in the vicinity of Site SS12. One sample each will be collected from fill material and native tundra and submitted for grain-size analysis (ASTM Method C136 and D442), soil permeability testing (ASTM Method D5084), and analysis of total organic carbon (EPA Method 9060). Shelby tubes will be used to collect undisturbed samples for permeability testing. Sampling will be conducted in areas determined to be free of contamination by the field team.

3.2.2.2 Areas of Concern. During the September, 1993 site survey, ten areas of concern (AOCs) were identified that warrant further consideration as potential sites during the RI/FS field sampling effort. These AOCs are in addition to the seven sites identified during previous IRP remedial investigations at Kotzebue LRRS that are being characterized as part of this remedial investigation as described in the above section. A brief description of each of the 10 AOCs is provided in Section 1.2.2, Previous Investigative Activities and Documentation. Figure 3-1 provides an installation diagram identifying the location of the 10 AOCs. Site investigation activities for identified AOCs are summarized in Table 3-3. Planned sampling and analysis activities at the AOCs are summarized in Table 3-1. The following section provides a description of field and sample analysis activities to be conducted at the 10 recently identified areas of concern.

AOC-1 Landfarm

Previous IRP RI/FS remedial actions conducted at Kotzebue LRRS include the excavation of approximately 100 yd^3 of contaminated soils and fill from the SSO1-Waste Accumulation Area No. 1, and of approximately 50 yd^3 from Spill No. 2 and approximately 350 yd^3 from Spill No. 3 at the SS12 Site. Excavated soils were stockpiled on a plastic liner in a landfarm constructed on the east side of the installation access road, directly east of the Composite Facility. Soils within the landfarm were mixed weekly over the course of two summer field seasons (1989 and 1990). A mean reduction in TPH concentrations was reported over time; however, elevated TPH concentrations were detected in landfarm soil samples collected at the end of the 1990 field season.

Remedial activities at Kotzebue LRRS were not continued following the 1990 field season, and the landfarm has not been maintained since that time. ADEC correspondence dated January 1992 indicates that the landfarm cover is torn and in poor condition, and that seepage has been identified adjacent to and below the eastern edge of the landfarm during an earlier site visit. During the September, 1993 site survey the landfarm area was inspected and found to be in relatively poor condition, with no cover to prevent infiltration and runoff, and with no access restrictions.

The proposed remedial investigation will include an initial inspection of the landfarm to evaluate the condition of the landfarm cell, the characterization of current soil conditions, and an evaluation of the

surrounding area to determine the potential extent of contamination if release(s) from the landfarm are evident.

Landfarm Condition Assessment--Tetra Tech personnel will evaluate the condition of landfarm containment by examining the ground surface surrounding the landfarm for indications of seepage or runoff. Evidence of seepage and/or runoff may indicate that a failure of the landfarm containment berms has occurred, potentially releasing contaminants to the surrounding area. Sample locations will be identified during the assessment based on visual observations and field screening techniques (see Section 3.2.5).

Landfarm Soil Sampling--Tetra Tech proposes to collect six soil samples from the existing landfarm to evaluate the current concentrations of compounds known or suspected to be present in landfarm soils. The soil samples will be collected from shallow handauger borings at six discrete locations within the landfarm cell. Soil samples collected from each boring will represent a vertical composite of landfarmed material. The maximum thickness of the landfarmed material is estimated to be 2.5 ft. All samples will be analyzed for diesel-range TPH using Method AK102. Three of the six soil samples will be analyzed for the presence of VOCs using EPA Method 8260, SVOCs using EPA Method 8270, and pesticides using EPA Method 8081. Two samples will be analyzed for total metals using the EPA Method 6000/7000 Series.

Perimeter Soil Sampling--Tetra Tech proposes to collect four to eight soil samples from locations that exhibit signs of leaching or runoff surrounding the existing landfarm. Soil samples will be analyzed for diesel-range TPH using Method AK102, VOCs using EPA Method 8260, SVOCs using EPA Method 8270, and pesticides using EPA Method 8081. Two samples will be analyzed for total metals using the EPA Method 6000/7000 Series.

AOC-2 POL Line

The POL Line, a 2-inch pipeline used to transport diesel fuel from the fuel storage tanks to the Composite Facility, runs from the beach tanks area uphill to the main facility. Previous investigations have not included an assessment of the pipeline.

POL Line Survey--Tetra Tech personnel will conduct a visual survey along the entire length of the pipeline to identify holes, loose or disconnected joints and fittings, and to identify any evidence of past leaks. Sample locations will be identified during the survey.

Soil Sampling--Tetra Tech proposes to collect from three to eight soil samples from locations along the existing POL Line that exhibit signs of having leaked fuel. If no leaks are apparent, the minimum number of samples (3) will be collected; one from the intake valve near the pumphouse, one from the outlet near the Composite Facility, and one along the pipeline trace at a joint. Soil samples will be analyzed for TPH as diesel fuel (Method AK102), VOCs using EPA Method 8260, SVOCs using EPA Method 8270, and pesticides using EPA Method 8081.

AOC-3 East Tanks

Two empty above-ground diesel fuel storage tanks (estimated capacity = 20,000 gal each) are located on the east side of the access road adjacent to Building 205. The tanks and surrounding area have not been assessed previously. Some limited soil staining directly beneath tank outlet valves was observed during the September 1993 site survey. Interim remedial actions being considered for the 1994 field season include the removal of both tanks.

Soil Sampling--Tetra Tech proposes to collect from three to six soil samples from locations under and/or surrounding the existing above-ground fuel tanks. These samples will be collected at locations that exhibit signs of leaked fuel based on field screening techniques (see Section 3.2.5). All samples will be analyzed for diesel-range TPH using Method AK102, VOCs using EPA Method 8260, SVOCs using EPA Method 8270, and pesticides using EPA Method 8081.

AOC-4 Garage/Power Plant

Stained soils were observed during the September 1993 site survey beneath the raised flooring of the power plant and in the garage area associated with the Composite Facility. The garage was the vehicle maintenance center for the facility, and past waste disposal practices associated with the garage area are not known. No previous characterization of soils beneath these facilities has been conducted, and characterization will incorporate analyses for a variety of compounds.

Garage/Power Plant Inspection--Tetra Tech personnel will inspect the interior of the power plant and garage facilities to identify past operations potentially involving the use of hazardous materials. The inspection will also locate any floor drains that could provide a pathway for hazardous substances to impact soils beneath these facilities.

Soil Sampling--Tetra Tech proposes to collect between four and eight soil samples from locations beneath the Garage/Power Plant area that exhibit signs of contamination. Sample locations will be determined using the field screening techniques outlined in Section 3.2.5, and will include area(s) beneath drain outlets, if encountered. All samples will be analyzed for gasoline-range TPH using Method AK101, diesel-range TPH using Method AK102, VOCs using EPA Method 8260, SVOCs using EPA Method 8270, and pesticides and PCBs using EPA Method 8081. Two samples will be analyzed for total metals using the EPA Method 6000/7000 Series.

AOC-5 Small Day-Tanks

A number of small day-tanks were formerly used throughout the installation for heating and equipment operation. Approximately 12 to 15 250-gal above-ground diesel fuel tanks are present at the facility. Diesel fuel releases could have occurred historically due to overfilling or by direct release from the tanks or tank lines. No previous assessment of the day-tanks as a group has been conducted. The day tanks were drained of any remaining fuel in 1993.

Soil Sampling--Tetra Tech proposes to collect up to 20 soil samples from locations under and/or surrounding day tanks at various locations at the facility. The samples will be collected at locations that exhibit evidence of leaked fuel based on visual observations and field screening techniques (see Section 3.2.5). A minimum of one sample will be collected at each tank location; more samples will be collected if significant contamination is directly observed. All samples will be analyzed for diesel-range TPH using Method AK102, VOCs using EPA Method 8260, SVOCs using EPA Method 8270, and pesticides using EPA Method 8081.

AOC-6 Navigational Aid Buildings (101 and 200)

The navigational aid building and an adjacent structure have been included for assessment based on elevated TPH concentrations in soils identified during a 1993 Environmental Site Assessment conducted at Building 101 (see Section 1.2.2.6). Assessment will include a building inspection and a survey of the surrounding area.

Building Inspection--Tetra Tech personnel will inspect structure interiors for indications of past operations involving the potential use or storage of hazardous materials. Floor drains and plumbing outlets will be identified to evaluate potential discharge locations.

Soil Sampling--Tetra Tech proposes to collect three to six soil samples from locations previously identified by elevated TPH concentrations (see Section 1.2.2.6), and from locations surrounding the navigational aid building that exhibit evidence of contamination based on visual observations and field screening results (see Section 3.2.5). All samples will be analyzed for diesel-range TPH using Method AK102, VOCs using EPA Method 8260, SVOCs using EPA Method 8270, and pesticides and PCBs using EPA Method 8081. Two samples will be analyzed for total metals using the EPA Method 6000/7000 Series.

AOC-7 Steel Pilings

Steel pilings were discovered southeast of the Composite Facility during the September 1993 site survey. Buildings identified during a review of historical aerial photographs suggest that this was a former construction camp established during the construction of the radar facility. Site characterization will include a visual inspection of the area and limited soil sampling based on field screening results.

Soil Sampling--Tetra Tech proposes to collect from three to six soil samples at locations surrounding the existing steel pilings based on visual observations and field screening results (see Section 3.2.5). If no indications of contamination are observed and no evidence of hazardous materials use is evident at the site, three samples will be collected based on professional judgment. Soil samples will be analyzed for diesel-range TPH using Method AK102, VOCs using EPA Method 8260, SVOCs using EPA Method 8270, pesticides and PCBs using EPA Method 8081. Two samples will be analyzed for total metals using the EPA Method 6000/7000 Series.

AOC-8 White Alice Garage

White Alice Garage was reportedly used for storing and servicing site vehicles, and has been recommended for assessment based on its operational history. The assessment will include an inspection of the garage facility and surrounding area. Limited soil sampling will be conducted based on visual observations and field screening results.

White Alice Garage Inspection--Tetra Tech personnel will inspect the garage interior for indications of past operations involving the potential use or storage of hazardous substances. Floor drains and plumbing outlets will be identified to evaluate potential discharge locations. The area surrounding the garage will be also be inspected for signs of contamination.

Soil Sampling--Tetra Tech proposes to collect three to six soil samples from locations in the garage and surrounding area that exhibit signs of contamination based on visual observations and field screening results (see Section 3.2.5). If no indications of contamination are observed and no evidence of hazardous materials use is evident at the site, three samples will be collected based on professional judgment. All samples will be analyzed for gasoline-range TPH using Method AK101, diesel-range TPH using Method AK102, VOCs using EPA Method 8260, SVOCs using EPA Method 8270, and pesticides and PCBs using EPA Method 8081. Two samples will be analyzed for total metals using the EPA Method 6000/7000 Series.

AOC-9 White Alice Tanks

Two empty above-ground diesel fuel storage tanks with an estimated capacity of 20,000 gal each are located adjacent to Building 1001 at the White Alice Station. The tanks and surrounding area have not been previously assessed. Limited soil staining was observed directly beneath tank outlet valves during the September 1993 site survey. Interim remedial actions currently being considered for the 1994 field season, include the removal of both tanks.

Soil Sampling--Tetra Tech proposes to collect from three to six soil samples at locations under and/or surrounding the above-ground fuel tanks. The samples will be collected at locations that exhibit signs of leaked fuel based on visual observations and field screening results (see Section 3.2.5). All

samples will be analyzed for diesel-range TPH using Method AK102, VOCs using EPA Method 8260, SVOCs using EPA Method 8270, and pesticides using EPA Method 8081.

<u>AOC-10 Septic Holding Tank</u>

Primary treatment of domestic sewage and wastewater at Kotzebue LRRS was provided by a single septic tank located west of the Composite Facility. Septic tank effluent was discharged into Kotzebue Sound via an outfall line.

Sludge and Soil Sampling--Tetra Tech proposes to collect one sludge sample from the facility septic tank to evaluate the characteristics of discharges to the former wastewater and sewage treatment system. If preliminary analytical results indicate the presence of contamination by hazardous materials, an assessment of the existing sewer line will be conducted. One to three soil samples will be collected at locations exhibiting evidence of leaks or other modes of contamination. All samples will be analyzed for diesel-range TPH using Method AK102, VOCs using EPA Method 8260, SVOCs using EPA Method 8270, pesticides and PCBs using EPA Method 8081, and total metals using the EPA Method 6000/7000 Series.

3.2.3 Background Characterization

Previous RI/FS field investigation activities at Kotzebue LRRS did not include the collection and analysis of background samples from the various media sampled in areas of concern. The concentration of contaminants in background samples provides the baseline concentration data necessary to evaluate site-specific samples collected from each media and source area during the proposed field sampling. Such evaluations are used to delineate source areas, recommend remedial actions, and evaluate media-specific concentrations relative to ARARs for the individual sites. Permission to collect background samples at locations outside the facility boundary will be obtained from property owner(s) prior to beginning field work at these locations. Background characterization will include all analyses performed and media sampled during the remedial investigation.

Soil Sampling--Tetra Tech proposes to collect three soil samples to evaluate background conditions in native tundra in the vicinity of the site. All background soil samples will be analyzed for the presence of gasoline-range TPH using Method AK101, diesel-range TPH using Method AK102, VOCs

using EPA Method 8260, SVOCs using EPA Method 8270, pesticides and PCBs using EPA Method 8081, and total metals using the EPA Method 6000/7000 Series.

Sediment Sampling--Tetra Tech proposes to collect six sediment samples to evaluate background conditions including three lake sediment samples and three beach sediment samples. All background sediment samples will be analyzed for the presence of diesel-range TPH using Method AK102, VOCs using EPA Method 8260, SVOCs using EPA Method 8270, pesticides and PCBs using EPA Method 8081, and total metals using the EPA Method 6000/7000 Series.

Groundwater Sampling--One background groundwater monitoring well will be installed north of Site SS02 in an area with no known or suspected upgradient source of contamination. One groundwater sample will be collected from this well to evaluate background groundwater conditions. In addition, three groundwater monitoring wells will be installed at Site SS02 to evaluate groundwater quality. Some or all of these three wells may potentially serve as monitoring points for groundwater that is unaffected by waste disposal activities or spills at the site. All of the background groundwater samples will be analyzed for a broad spectrum of contaminants, including diesel-range TPH using Method AK102, VOCs using EPA Method 8260, SVOCs using EPA Method 8270, pesticides and PCBs using EPA Method 8081, and both total and dissolved metals using the EPA Method 6000/7000 Series. Four upgradient groundwater monitoring wells will be installed and sampled at Site ST05, Beach Tanks; these samples will be analyzed for a more limited suite of contaminants, including diesel-range TPH using Method AK102, VOCs using EPA Method 8260, SVOCs using EPA Method 8270, and geochemical and conventional parameters. These wells will provide upgradient groundwater quality samples for Site ST05, and may potentially be used to augment the background groundwater samples discussed above if these wells are unaffected by distal upgradient source areas.

Surface Water Sampling--Tetra Tech proposes to collect three surface water samples to evaluate background concentrations in the vicinity of the site. Proposed background sample locations for surface water samples are presented in the companion Field Sampling Plan. A suite of geochemical parameters will be collected at a lake to provide background concentrations for conventional and other parameters for surface water in an area unaffected by petroleum hydrocarbon concentrations. These data will be used to evaluate geochemical results for surface water samples collected at Site SS12-Spills No. 2 and 3 in

support of the evaluation of natural biodegradation. All background surface water samples will be analyzed for diesel-range TPH using Method AK102, VOCs using EPA Method 8260, SVOCs using EPA Method 8270, pesticides and PCBs using EPA Method 8081, and both total and dissolved metals using the EPA Method 6000/7000 Series.

Seawater Sampling--Tetra Tech proposes to collect one seawater sample to evaluate background conditions in Kotzebue Sound. The background seawater sample will be analyzed for diesel-range TPH using Method AK102, VOCs using EPA Method 8260, and SVOCs using EPA Method 8270.

3.2.4 Quality Control Sampling

Quality Control (QC) sampling will be conducted in the field to ensure the reliability of project samples and the usefulness of the data. A detailed discussion is provided in the QAPP portion of the SAP, including the definition and purpose of specific quality control samples. Table 3-2 identifies field QC samples and associated analyses for Kotzebue LRRS. QC samples for Kotzebue LRRS will include the following:

- **Trip Blank**--One trip blank will accompany every cooler of environmental samples sent to the analytical laboratory for the analysis of VOCs. Trip blanks consist of two sealed 40-mL VOA sample bottles filled at the analytical laboratory with Type II Reagent Grade Water. The sealed trip blanks accompany the routine sample containers from the laboratory to the field, during sample collection, and during transport of the samples back to the analytical laboratory.

- **Temperature Blanks**--One temperature blank will accompany every cooler containing soil and water samples sent to the laboratory for chemical analysis. The temperature blanks will consist of two 40-mL VOA vials filled with Type II Reagent Grade Water and will be labeled temperature blanks. The sealed temperature blanks will accompany the routine sample containers during shipment from the field to the analytical laboratory. The temperature in the ice chest is checked by opening one of the temperature blanks and inserting a thermometer or thermocouple probe in the water. This provides a much more representative sample temperature than does the air temperature in the ice chest.

- **Ambient Condition Blanks**--Ambient condition blanks will be collected at a 10 percent sample (VOC sample) frequency or one ambient condition blank will be collected for every VOC sampling event (whichever is fewer). Type II Reagent Grade Water will be used to fill four 40-mL VOA vials. The vials will be filled by pouring the lab water through the open air during sampling at each site and AOC. Vials will be filled on an intermittent basis during sampling, such that all four vials span the field sample collection activities at a given site or AOC. The ambient condition blanks will be analyzed for VOCs at the laboratory in conjunction with the corresponding field samples.

- **Equipment Rinsate Blanks**--Equipment blank samples will be collected daily from sampling equipment used to collect 10 or more field samples. If less than 10 samples are collected within a day, equipment blanks will be collected based on a running cumulative total at a 10 percent frequency. The equipment rinsate blanks will be analyzed for all compounds of concern for a given sampling activity (e.g., analytical suite and equipment used).

- **Field Duplicate Samples**--Ten percent of all water and soil/sediment samples collected will be field duplicate samples. Field duplicate samples will be labeled such that laboratory personnel are unable to distinguish them from the associated field sample. Care will be exercised to document the association between each duplicate sample and the corresponding field sample, and to correctly record their sample designations in the field logbook. The field duplicate samples will be analyzed for the same analytes as are specified for the associated field samples.

3.2.5 Field Screening Techniques

During site reconnaissance, a PID will be used to identify surface soils and structures with elevated concentrations of ionizable organic vapors. Elevated readings will identify the specific areas to be considered for sampling at sites and areas of concern. During sampling activities, a PID will also be used to screen samples and prioritize those selected for laboratory analysis.

All sample material will be screened for the presence of contaminants using a photoionization detector (PID; e.g., HNu or equivalent) and, where applicable, field test kits. Field screening will be conducted

during the collection of surface soil samples, near-surface soil sampling using a hand auger, and the collection of subsoil samples during drilling. Field screening activities will be performed according to the guidelines described below.

Screening Using a PID

- For subsoil samples collected during drilling: the tip of the PID will be inserted between adjacent brass sample liners in the split spoon sampler immediately upon retrieval of the sampler from the borehole. The PID response will be recorded on the boring log.

- For surface soil samples and hand-augered soil samples: a wide-mouth glass jar will be filled approximately halfway with recovered sample material. The mouth of the jar will be covered with aluminum foil.

- The covered jar will then be set aside for a brief period (approximately 5 minutes) in a warm area, if available.

- After the 5 minutes, the tip of the PID will be pushed through the aluminum foil and the level of total ionizable compounds in the head space of the jar will be read from the PID and recorded in the daily field logbook.

Screening Using Field Test Kits--Field screening of soil samples for the presence of TPH and PCBs will be performed using field test kits, where appropriate. Samples will be screened for the presence of TPH using a commercially available petroleum hydrocarbon test kit. PCB screening will be performed using Dexsil CLOR-N-SOIL® field test kits. All sample screening will be performed following the instructions supplied with the kits by the manufacturer. All field screening results will be recorded in the daily field logbook.

3.2.6 Investigation Derived Waste Management

Decontamination Procedures--All down-hole drilling equipment used for the field investigation will be decontaminated between borings. All sampling equipment will be decontaminated between sampling intervals. All decontamination will be performed following guidelines established in Section 2.1.1.3 of the *IRP Handbook*.

Waste Containerization--Subsoil sampling, groundwater monitoring well installation, groundwater sampling, and the decontamination of field equipment will all generate investigation-derived wastes, including wastewater, soils, and protective clothing. The minimization of investigation-derived wastes is an important objective when planning the design of field sampling activities. Wastes produced during the investigation will be handled as described below:

- All decontamination wastewater will be containerized in drums, properly labeled, and stored onsite. At the completion of RI/FS field activities, the decontamination waste water will be pumped through an in-field carbon filtration system, recontainerized, and sampled to evaluate potential hazardous constituents. Disposal alternatives for decontamination waste water will be determined based on the sample analytical results obtained for these samples.

- Wastewater generated during monitoring well installation and groundwater sampling will be containerized in drums, properly labeled and stored on site. Disposal options for wastewater from each well will be determined based on the results of chemical analyses conducted on the groundwater samples. Non-contaminated water will be released to the environment. Contaminated water will be pumped through an in-field carbon filtration system, recontainerized, and resampled to determine the remaining concentrations of hazardous constituents. Disposal alternatives for filtered wastewater will be evaluated based on the sample analytical results obtained for these samples.

- Waste soils generated during drilling will be properly contained in sealed open-top drums, properly labeled, and stored onsite. Waste soils will be segregated by site/AOC. Alternatives for soil disposal will be evaluated based on sample analytical results. TPH contaminated soils may be subsequently added to the existing landfarm and treated with other TPH contaminated soils. Soils containing contaminants in addition to those identified in samples from the landfarm will be segregated and further evaluated for disposal alternatives. No soil borings will be advanced into permafrost during drilling activities.

- Soil generated during the hand-augering of near-surface soil samples will be returned directly to the shallow hand-augered boring. These shallow borings cannot be advanced

to permafrost, and thus will not unduly promote the vertical migration of potential contamination.

- All wastes containerized in drums will be segregated by type and matrix (soil, waste-water, etc.). The waste drums shall be sealed and secured at the end of each work day. The waste drums will be labeled with a description of the waste matrix, origin of the waste (e.g. borehole number, etc.), the volume or quantity of waste, the activity that generated the waste, the date(s) the waste was generated, the site or AOC name, and the name and telephone number of a USAF contact.

- Tetra Tech will assist the USAF with arrangements for the final disposition of the wastes generated in the course of the investigation as instructed by USAF. However, the USAF is ultimately responsible for final disposition of the wastes.

3.2.7 Surveying

All sample locations will be identified with a marking flag bearing the sample designation. These marking flags will remain in place until the sample locations have been surveyed following guidelines established in Section 2.1.1.5 of the IRP Handbook. It is anticipated that USAF personnel from the 611 CES will conduct sample location and monitoring well elevation surveying activities. Tetra Tech will provide assistance in locating sample locations to the surveyor.

3.2.8 Potential Interim Remedial Actions

Potential interim remedial actions are being considered for certain sites at the Kotzebue LRRS by the 611 CES at Elmendorf AFB. These potential interim remedial actions include: 1) limited excavation of known source areas at the SS12 Spills No. 2 and 3 Site, 2) the removal of above-ground storage tanks (e.g., at the AOC-3 East Tanks site and AOC-9 White Alice Tanks site); 3) limited site characterization surrounding these tanks (see 2 above)following their removal; 4) the repair of containment structures at the AOC-1 Landfarm site; and 5) possible recontainment of landfarm soils. These potential interim remedial actions are beyond the existing scope of work identified for the Kotzebue LRRS RI/FS by the Air Force and Tetra Tech.

The existing scope of work restricts participation by Tetra Tech in major aspects of the proposed interim remedial actions while engaged in the RI/FS field sampling activities. The short duration of the field season at Kotzebue LRRS will ensure that a contractor selected to perform interim remedial actions will be present at the facility during the RI/FS field sampling activities described in this Work Plan. Should USAF personnel wish to direct Tetra Tech to provide technical oversight for the potential interim remedial actions discussed above, a contract modification would be required. Once the interim remedial actions are identified for implementation and a contract modification is issued, Tetra Tech will provide a written addendum to this Work Plan addressing technical oversight activities. Tetra Tech would then be responsible for, and intend to direct, all field operations at the site in a manner that prevents conflicts between contractors and efficiently achieves project objectives.

3.3 LITERATURE SEARCH

A literature search has been conducted to supplement and support information previously collected for the Kotzebue LRRS RI/FS, providing the information necessary to complete the site conceptual model and support risk assessment activities. Kotzebue LRRS background information, including previous IRP activities, federal and state regulatory involvement and documentation, and Base Historian information for Kotzebue LRRS, was provided by AFCEE and the 611th Air Support Group, Civil Engineer Squadron (611 CES), Elmendorf AFB, Anchorage, Alaska. Literature search activities conducted to date to supplement and support the existing background information have included the following sources and information:

- U.S. Department of Fish and Wildlife--National wildlife refuge information has been obtained for the area surrounding Kotzebue, Alaska.

- U.S. Department of the Interior--National parklands and associated natural resources information has been obtained through the National Park Service.

- U.S. Geological Survey (USGS)--For Kotzebue topographic map quadrangles D-1 and D-2, and aerial photographs of Kotzebue LRRS.

- Alaska Department of Fish and Game--Subsistence and sociocultural information for Kotzebue, Alaska has been obtained through the Division of Subsistence.

- Alaska Department of Environmental Conservation (ADEC)--The most current active and proposed environmental regulations have been obtained.

- Alaska Department of Natural Resources--The publications catalog of the Alaska Division of Geological and Geophysical Surveys was obtained and reviewed for relevant papers.

- Aerial Photographs--Aerial photographs of Kotzebue LRRS dating from 1952 to 1993 were obtained from the USGS and from private sources, including Aeromap U.S., Inc, and Walker and Associates, located in Anchorage, Alaska.

- Database Review--The University of Washington Library's general database was searched for specific topics including Kotzebue, permafrost, arctic tundra, and petroleum hydrocarbon remediation in arctic regions. Additionally, the on-line database system Dialog was used to search two databases, Environline and Pollution Abstracts, to identify information regarding petroleum hydrocarbon remediation in arctic regions.

- Risk Assessment--The literature search conducted in support of risk assessment included information regarding terrestrial and per capita aquatic-organism consumption rates for Kotzebue, factors affecting root uptake of contaminants by plants, and principles of animal/human risk extrapolation. Additionally, several U.S. EPA sources were identified for risk assessment use at Kotzebue LRRS. Risk assessment information sources are provided in the references section of this work plan.

3.4 RECORDKEEPING

Records of field and laboratory activities maintained to document the IRP RI/FS effort at Kotzebue LRRS will be consistent with the format and requirements established in the *IRP Handbook*. All data gathered during the work effort at Kotzebue LRRS will be detailed into appropriate Analytical Data Informal

Technical Information Reports (ITIRs) to meet the data deliverable requirements of the Installation Restoration Program Information Management System (IRPIMS).

Recordkeeping maintenance for field activities to be conducted at Kotzebue LRRS, including base maps, field data sheets, the field logbook, the sample custody/shipping notebook, and photo logs are detailed in the Field Sampling Plan (FSP) portion of the SAP, Section 3.5. The laboratory will maintain sufficient records to recreate each analytical event conducted pursuant to the Kotzebue LRRS Statement of Work, maintain and use written procedures for each analytical method and QA/QC function, and present data in hard copy and in a computerized format consistent with the SOW. Recordkeeping in support of laboratory activities are specified in the Quality Assurance Project Plan (QAPP) portion of the SAP.

3.5 DATA ASSESSMENT

Project data collected for the Kotzebue LRRS RI/FS will be assessed and analyzed to identify accurate and valid data, and to refine site models in accordance with the requirements established in the *IRP Handbook*. Data assessment criteria and methodology for Kotzebue LRRS is detailed in the QAPP portion of the companion SAP.

Data quality objectives (DQOs) are qualitative and quantitative statements developed by data users to specify the quality of data obtained from field and laboratory data collection activities, and that are to be used to support specific decisions or regulatory actions. The DQOs describe what data are needed, why the data are needed, and how the data will be used to address the problem under investigation. Data needs for Kotzebue LRRS include both screening-level measurements and data of sufficient quality to be used in the health and ecological risk assessment, in the feasibility study, and to ensure compliance with ARARs. In addition, sufficient information must be provided to meet the requirements of the IRPIMS database.

The U.S. EPA has established a hierarchy of DQOs that are qualitative and quantitative statements that specify the quality of data required to support regulatory decisions during remedial response. For data collected during the work effort at Kotzebue LRRS, the main analytical program will be performed at a fixed base laboratory at Analytical Support Level III, with rigorous documentation performed according

to the *IRP Handbook* Level I data reporting requirements. The field screening analyses included in the geophysical and tidal surveys will be conducted according to Analytical Support Level II protocols. Site-specific health and safety screening, measurement of parameters during environmental sample collection, and measurements associated with well development and purging will be conducted according to Analytical Support Level 1 protocols. Ten percent of the Analytical Support Level III data packages will be submitted in a U.S. Air Force Level II [Contract Laboratory Program (CLP)-equivalent] format. These packages will be validated by a third-party validator or Tetra Tech, Inc.'s validation staff. U.S. Air Force level I and Level II data reporting requirements are detailed in Section 9.0 of the QAPP.

The quality criteria employed for the Kotzebue LRRS RI/FS address the following data characteristics: accuracy, precision, completeness, representativeness, and comparability. Project data quality objectives and a quality criteria assessment for the Kotzebue LRRS RI/FS are presented in detail in the QAPP. Data validation will be performed on data generated by the laboratory as specified in the SOW and according to the *IRP Handbook* and, where applicable, using the following documents:

- National Functional Guidelines for Organic Data Review, Multi-Media Concentration (OLM01.1) and Low Concentration Water (OLC01.0; U.S. EPA Draft 1991a)

- National Functional Guidelines for Organic Data Review, Multi-Media Concentration (OLM01.1) and Low Concentration Water (OLC01.0), Draft Functional Guidelines for Organics for Pesticide Fractions (U.S. EPA Draft 1991a)

- Laboratory Data Validation Functional Guidelines for Evaluating Inorganics Analyses (U.S. EPA 1988).

Additional data assessment information, including field and laboratory internal quality control checks, laboratory performance and system audits, and corrective action measures are described in the QAPP portion of the companion SAP.

3.6 BASELINE RISK ASSESSMENT

A focused baseline risk assessment may be conducted as part of the pending remedial investigation at Kotzebue LRRS. The need to conduct a baseline risk assessment will be determined based on remedial investigation results and a detailed evaluation of applicable ARARs. The baseline risk assessment would be conducted to provide an estimate of the potential risk to human health and the environment associated with various exposure scenarios involving site contaminants in the absence of remediation. The results of the baseline risk assessment may be used to: 1) support a "No Further Action" decision, 2) prioritize the needs for remediation at various sites, or 3) provide a basis for the quantification of remedial objectives. An ecological assessment constitutes an integral part of a focused baseline risk assessment, and is used to evaluate the potential effects of contaminants at the study area. The ecological assessment would focus on estimating potential risks to identified target or indicator species, and would not incorporate biological diversity or population studies.

The following sections describe the baseline risk assessment approach for both human health and ecological concerns at Kotzebue LRRS. The general methods for estimating human health and ecological risks are discussed, and existing data needs are identified.

3.6.1 Selection of Site Contaminants

Site contaminants are those hazardous substances detected in environmental samples at concentrations greater than background levels. For inorganic analyses, site contaminants are those detected at or above three times the mean background concentrations. No background concentrations for soil, surface water, or groundwater were characterized during previous IRP investigations conducted at Kotzebue LRRS. Background concentrations will be established through the collection of background samples for each analysis conducted and media investigated at the site as described in Section 3.2, Field Investigation. The maximum concentrations of organic compounds and metals detected in soil, surface water, and groundwater samples collected during previous IRP investigations at Kotzebue LRRS are presented in Tables 1-3 and 1-7.

The primary environmental problem identified at Kotzebue LRRS is petroleum hydrocarbon contamination linked to past installation operations and activities. Petroleum hydrocarbon contamination at Kotzebue LRRS has primarily been characterized by measuring total petroleum hydrocarbons (TPH). Routine

analyses of individual volatile and semivolatile compounds was not conducted during previous IRP investigations, thwarting attempts to quantify potential human or ecological risks associated with individual toxicants. Additional site characterization will incorporate volatile and semivolatile organic analyses at identified source areas to address this data gap.

3.6.2 Exposure Assessment

The objective of the exposure assessment is to identify actual and potential exposure pathways, to characterize receptor populations, and to estimate the magnitude and rate of exposure for complete exposure pathways.

3.6.2.1 Pathways Analysis. The Kotzebue LRRS Site Conceptual Model (Section 2.3) identifies potential exposure pathways for both human and ecological receptors based on an evaluation of contaminant sources.

Human Receptors--Potential human receptors currently identified at Kotzebue LRRS include USAF personnel, recreational users (e.g., ATV operators, picnickers, beach combers), and subsistence uses (e.g., terrestrial and marine hunting, fishing, and berry picking). As part of a baseline risk assessment further human receptor evaluation will be conducted to defined and quantify potentially exposed populations, with consideration given to both current and future site use.

Ecological Receptors--The potential ecological receptors identified in the Kotzebue LRRS site conceptual model are general terrestrial and aquatic organisms that may be present within the study area. A general description of native vegetation, fish, wildlife, and threatened or endangered species associated with the Kotzebue area is provided in Section 2.1.7, Biology. Additional ecological characterization will include a thorough literature search and subsequent confirmation with local, state, and federal Natural Resource Trustees to identify terrestrial, intertidal, and fully aquatic species indigenous to Kotzebue LRRS and the surrounding area. As part of this review process, key plants and animals associated with the site will be selected for evaluation in the ecological risk assessment. The U.S. Fish and Wildlife Service will be consulted in the development of the ecological risk assessment. Critical habitats and

sensitive environments will be identified, as well as important or endangered species (target species) that may inhabit or migrate through the study area.

3.6.2.2 Estimation of Chemical Intake. Potential intakes for human and ecological receptors will be determined based on contaminant source characterization and associated exposure pathways identified in the site conceptual model. Maximum potential chemical intake will be estimated for human and ecological receptors based on contaminant concentrations, estimates of frequency of contact, and estimates for duration of exposure.

Human Receptors--The objective for this portion of the risk characterization is to estimate the rate of contaminant transport to identified target human populations via the exposure routes identified in Section 2.3, Site Conceptual Model. The primary exposure routes that will be evaluated are:

- Ingestion

- Dermal contact

- Consumption of terrestrial and aquatic organisms by recreational and subsistence hunting/fishing.

The level of chemical exposure resulting from ingestion depends on the concentration of the contaminant, the amount ingested, the receptor body weight, and the frequency and duration of exposure. Chemical-specific ingestion rates will be calculated using site-specific measurements of chemical concentrations. Values for the other exposure parameters needed to estimate ingestion of chemicals will be derived by considering site-specific exposure characteristics and typical exposure assumptions provided in human-health-risk guidance manuals (e.g., U.S. EPA 1989a, 1991, 1993). In addition, the evaluation of exposure scenarios will include information obtained from the local community and community officials regarding average and reasonable maximum exposure assumptions.

The level of chemical exposure by dermal contact can be estimated as a function of the contaminant concentration, the skin area exposed, the fraction of chemical absorbed through the skin, receptor body weight, and the frequency and duration of exposure. Chemical-specific estimates of dermal intake will

be calculated using site-specific measurements of chemical concentrations. Values for the other exposure parameters needed to estimate dermal intake of chemicals will be derived by considering site-specific exposure characteristics and typical exposure assumptions provided in human-health-risk guidance manuals (e.g., U.S. EPA 1989a; 1991; 1993). In addition, U.S. EPA Region 10 guidance will be consulted to provide standard exposure values that will be modified to account for site-specific information (e.g., climatic conditions) that directly effect media-specific exposure scenarios (1991 Memorandum, Supplemental Guidance for Superfund Risk Assessments in Region 10).

The level of chemical exposure from the consumption of aquatic and terrestrial organisms can be estimated as a function of the contaminant concentration in the portion consumed, the rate of consumption, the fraction of the chemical absorbed, receptor body weight, and the frequency and duration of exposure. Contaminant concentrations in aquatic organisms will be estimated using site-specific measurements of chemical concentrations in groundwater, together with chemical-specific bioconcentration factors derived from the literature. Contaminant concentrations in terrestrial organisms will be estimated using food web models based on measured site-specific chemical concentrations in sediment, chemical uptake rates in plants, and allometric models of food consumption for selected wildlife (Calabrese 1983; Suter 1993). Consumption rates for recreational and subsistence hunters and fishermen will be estimated using available local information (e.g., Schroeder et al. 1987; Fall and Utermohle 1993) and/or data obtained from national surveys (e.g., U.S. EPA 1989b). Values for the other exposure parameters needed to estimate consumption of chemicals from recreational and subsistence hunting and fishing will be derived by considering site-specific exposure characteristics and typical exposure assumptions provided in human-health-risk guidance manuals (e.g., U.S. EPA 1989a, 1991, 1993).

Ecological Receptors--The objective for this portion of the risk characterization is to estimate the rate of contaminant transport to specific target, or endpoint, plants, animals, fishes, and birds (as described in Section 3.6.2.1) associated with Kotzebue LRRS and the surrounding area via the exposure routes identified in Section 2.3, Site Conceptual Model. The primary exposure routes that will be evaluated are identified below:

- Ingestion of soil and sediment

- Dermal contact with sediment and water

- Plant uptake

- Food chain interactions (e.g., seals, salmon, other predators, juvenile fish and other consumers of algae and phytoplankton and secondary producers, raptors)

The general approach that will be used to estimate contact with, or doses to, the endpoint organisms affected by the above exposure routes will be to develop a conceptual model that considers the media that the chemicals of interest are detected in, and the processes that will exert control on the exposure of endpoint organisms to contaminants (i.e., dilution, degradation, partioning among different media, chemical uptake, and food web interactions). The complexity of this model will depend upon the availability of data and the specific characteristics of the endpoint organisms selected. Because of the physical characteristics of the Kotzebue LRRS and the uncertainty associated with chemical transport along certain pathways (particularly the soil - organism uptake route), it is anticipated that it may be necessary to make several simplifying assumptions to allow estimation of exposure to endpoint organisms. All assumptions, and their potential impact on numerical estimates of exposure, will be clearly stated in the risk characterization. In the following text, the variables affecting chemical uptake and exposure via each of the exposure routes listed above are described.

The level of chemical exposure from ingestion depends on the concentration of the contaminant, the amount ingested, the receptor body weight, and the frequency and duration of exposure. Chemical-specific ingestion rates will be calculated using site-specific measurements of chemical concentrations. Values for the other exposure parameters needed to estimate the ingestion of contaminants will be derived by considering site-specific exposure characteristics and general knowledge about the habits of target species derived from literature searches.

The level of chemical exposure by dermal contact can be estimated as a function of the contaminant concentration in the skin area exposed, the fraction of chemical absorbed through the skin, and the frequency and duration of exposure. Chemical-specific estimates of dermal intake will be calculated using site-specific measurements of chemical concentrations. Values for the other exposure parameters needed to estimate dermal intake of contaminants will be derived from literature searches and by considering site-specific exposure characteristics.

Terrestrial plants may be exposed to contaminants through direct contact with contaminants in the root zone within the soil, by volatilization, and from leaf uptake. Aquatic plants may be exposed to contaminants through direct contact with sediments, and by direct contact with contaminated surface water or seawater. The level of exposure will be estimated using site-specific measurements of chemical concentrations and applicable literature values (e.g., Briggs et al. 1982; Topp et al. 1986).

The level of chemical exposure from the consumption of aquatic and terrestrial organisms through food chain interactions can be estimated as a function of the contaminant concentration in the organism consumed, the rate of consumption, the fraction of the chemical absorbed, receptor body weight, and the frequency and duration of exposure. Contaminant concentrations in aquatic organisms will be estimated using site-specific measurements of chemical concentrations in groundwater, sediments, surface water, and using chemical-specific bioconcentration factors derived from the literature. Contaminant concentrations for terrestrial organisms will be estimated using food web models based on measured site-specific chemical concentrations in sediment, chemical uptake rates in plants, and allometric models of food consumption for selected wildlife (Calabrese 1983; Navy 1987; Suter 1993).

3.6.3 Toxicity Assessment

Toxicity assessment will be based on the evaluation of toxicity information available for selected site contaminants to determine their potential to cause adverse health effects in receptors. The approach used to assess toxicity is different for human health consideration versus than used for ecological risk assessment. The following sections discuss the general approach used to evaluate toxicity in both human and ecological receptors.

3.6.3.1 Human Toxicity Assessment. Estimation of the risks to human populations for chemicals associated with the Kotzebue LRRS will use dose-response data for carcinogenic and noncarcinogenic chemicals compiled in two U.S. EPA-approved toxicity criteria databases: 1) the Integrated Risk Information System (IRIS; U.S. EPA 1993b); and 2) the Health Effects Assessment Summary Tables (HEAST; U.S. EPA 1993c). Risk characterization will be possible only for those chemicals with toxicity information entered in one of these databases.

The toxicological potency of carcinogens listed in these databases is characterized by chemical-specific carcinogenic potency factors (often referred to as slope factors). These factors are a measure of the

cancer-causing potential of a substance. The toxicological potency of noncarcinogens is characterized by a reference dose (RfD), which is an estimate of the daily exposure to the human population that is likely to produce an appreciable risk of adverse health effects during a lifetime (U.S. 1989b).

3.6.3.2 Ecological Assessment. Appropriate assessment (e.g., organism health) and measurement (e.g., mortality, growth) endpoints will be derived through a scientific literature search and through site-specific knowledge of local aquatic, intertidal, and terrestrial species gained during the RI field sampling activities, as discussed above in Section 3.6.2.1. The environmental concentrations of contaminant(s) that are likely to cause changes in assessment or measurement endpoints of target species will be derived from literature values. In cases where data are not available regarding contaminant concentrations that may affect assessment endpoints of concern in specific target species, other toxicity or biological endpoint data (e.g., lethal concentration, 50 percent [LC_{50}]; or lowest observable effect level [LOEL]) may be used to derive a surrogate for the effective concentration. If toxicity data are unavailable, EPA ambient water quality criteria or other no observable effect level (NOEL)-type data may be used.

3.6.4 Risk Characterization

Risk characterization will combine the information obtained as described in the previous sections to quantitatively estimate risk and interpret the significance of the estimated risk. In order to characterize the potential risk associated with Kotzebue LRRS sites, certain aspects of site characterization need to be expanded, including the chemicals of concern, chemical-specific environmental concentrations potential receptors, and physical processes (pathways analysis). Chemical characterization consists of two major components: chemical speciation (e.g., Method 8270 analyses for soil and water), and a review of literature regarding toxicant components of arctic diesel fuel and jet fuel. Receptor characterization will include a detailed literature search to adequately identify and describe ecological receptors, such as those associated with lake and beach environments at Kotzebue LRRS, and other ecological receptors of potential importance regarding human health risks associated with subsistence and recreational uses. Physical characterization of site characteristics that are pertinent to the potential for chemical migration in the environment, including tidal fluctuation, wave action, beach sediment characterization, and controls on groundwater transport, will require further assessment.

As part of the risk characterization, data will be obtained to specifically address whether natural biodegradation is active, and to what extent natural biodegradation may be responsible for a reduction

of petroleum hydrocarbon contaminant concentrations in specific media and environments at Kotzebue LRRS. Geochemical parameters will be measured in surface waters and groundwaters both upgradient and downgradient of known source areas to document the relationship between aqueous geochemistry and contaminant chemistry, allowing an evaluation of the effect of natural biodegradation on these two impacted media at two known source areas, the STO5-Beach Tanks Site (groundwater) and the SS12-Spills No. 2 and 3 Site (surface water).

Diesel fuel is a complex mixture of hydrocarbons produced by the distillation of crude oil. The dominant hydrocarbons in fresh diesel fuel are n-alkanes in the range C_9 to C_{20}. Analyses have shown that the dominant compounds found in degraded diesel fuel are isoprenoids (Christensen and Larsen 1993). Differences in the composition of fresh and degraded diesel fuel can be expressed in terms of a ratio between n-alkanes and isoprenoids (e.g., C_{17}/pristane). Diesel fuel TPH analyses typically measure hydrocarbons in the range of C_9 to C_{20}, and an evaluation of n-alkanes/isoprenoids ratios will provide an independent method to estimate the degree and natural degradation of diesel fuel contamination in soils at Kotzebue LRRS.

The following sections describe how the data assembled in the previous sections will be used to quantitatively estimate risk and interpret the significance of the estimated risk.

3.6.4.1 Human Health. Risk characterization for human health will combine the results of the exposure and the dose-response assessments for chemical contaminants detected in soil, surface water, and groundwater to estimate the probability and extent of adverse effects associated with chemical exposure to humans from Kotzebue LRRS. The risk characterization will include a discussion of the assumptions and uncertainties inherent in the risk assessment and their potential impact on the numerical estimates of risk.

Numerical estimates of potential risk will be presented separately for carcinogenic and noncarcinogenic chemicals. For carcinogens, the excess lifetime risk will be estimated by multiplying the chemical-specific carcinogenic potency factor (Section 3.6.3.1) by the exposure dose from all exposure pathways (Section 3.6.2.2). The carcinogenic effects of contaminants shall be considered to be additive. Thus, an estimate of the potential risk from carcinogenic chemicals will be added together to obtain an estimate of the overall risk associated with carcinogenic contaminants. For noncarcinogens, estimates of risk will

be calculated by dividing the exposure dose from all exposure pathways (Section 3.6.2.2) by the chemical-specific reference dose (Section 3.6.3.1). Risks for noncarcinogens will also be considered to be additive, and will be combined in a manner similar to that described for carcinogens.

3.6.4.2 Ecological Risk. The ecological risk characterization will combine the results of the exposure and the dose-response assessments for chemical contaminants detected in soil, surface water, and groundwater to estimate the extent of adverse effects associated with chemical exposure to selected target species identified to be present at Kotzebue LRRS. The ecological risk characterization will include a discussion of the assumptions and uncertainties inherent in the risk assessment and their potential impact on the numerical estimates of risk.

The first step in the ecological risk characterization will be to assess the likelihood of adverse impacts to the target species. The present and future potential exposure of target species to the contaminants of concern will be characterized based on environmental fate and transport as predicted by the site conceptual model, frequency and duration of contact, bioaccumulation potential, and food chain considerations. Seasonal variations that may influence scenarios will be considered. Ecological risks will be quantitatively characterized by using the ecological quotient (EQ) method, where EQ = observed contaminant concentration/effective concentration. When appropriate dose-response data are available, they will be included in the assessment.

Evaluation of the consequences of the identified risks will be described. It is anticipated that the endpoints to be evaluated will be direct measures of impact. In these cases, the need for a detailed evaluation of the consequences is minimized. For example, if the EQ value is very low (i.e., much less than 1) then the potential for risk is considered to be low; likewise, if the EQ value is much greater than 1, the potential for ecological risk is high.

3.6.5 Evaluation of Risk

The risk estimates for carcinogens and non-carcinogens shall be evaluated to determine whether any population groups are in imminent danger, and to identify contaminants posing the greatest risk so that remedial actions can be directed at those chemicals. Human exposure point-concentration estimates shall be

compared to ARARs as a way of assessing potential adverse effects associated with a site. The total risk to exposed populations posed by sites on the installation will also be evaluated. Finally, all risk assessment findings shall include a detailed discussion regarding the uncertainties inherent to the assessment.

3.7 BENCH SCALE/TREATABILITY STUDIES

A pilot-scale bioremediation treatability study is being considered to evaluate TPH contaminated soils associated with the AOC1-Landfarm and Site SS12-Spills No. 2 and 3. If a pilot-scale treatability study is to be conducted in support of the Kotzebue LRRS RI/FS during the summer of 1994, a detailed treatability study work plan will be prepared and approved prior to implementation of the study.

A previous IRP feasibility study conducted for Kotzebue LRRS included a recommendation for *in situ* bioremediation (no groundwater recapture) for groundwater associated with ST05-Beach Tanks Site. Additionally, it was recommended that a bench-scale treatability test be conducted using ST05-Beach Tanks subsoils and groundwater to further evaluate the *in situ* bioremediation alternative. A natural biodegradation assessment will be conducted using groundwater samples associated with the ST05-Beach Tanks Site. This assessment will include geochemical, conventional, and macronutrient parameter analyses, providing further information necessary to evaluate the *in situ* bioremediation alternative.

3.8 DETAILED ANALYSIS OF REMEDIAL ALTERNATIVES

The purpose of this section is to describe the process to conduct a detailed analysis of alternative remedial actions and to identify a recommended alternative. The detailed evaluation shall identify the remedial technology most likely to be successful for each recommended remedial approach identified by the screening study.

The purpose of the detailed analysis is to develop remedial alternatives that will reduce, control, and/or eliminate risk to acceptable levels of protection of human health or the environment. Procedures and guidelines for conducting a detailed analysis of remedial alternatives are specified in the *IRP Handbook* and in U.S. EPA OSWER Directive 9355.3-01, Guidance for Conducting Remedial Investigations and

Feasibility Studies Under CERCLA. The following text describes the process by which remedial alternatives will be identified and evaluated, and the most appropriate technologies recommended for implementation.

A three-step process will be used to conduct a detailed analysis of alternative remedial actions and to identify a recommended alternative. The evaluation process will include the development of remedial alternatives, remedial alternative screening, and the detailed analysis of selected screened alternatives. The assessment of remedial alternatives will also consider the unique logistic and climatic constraints imposed by the site's location.

Step 1. Development of Remedial Technologies

a) Remedial action objectives will be determined for each site based on risk assessment results and ARARs identification. The remedial action objectives will consist of medium-specific goals for protecting human health and the environment.

b) General response actions will be developed that will describe those actions that will satisfy the remedial action objectives. These actions may include containment, treatment, excavation, extraction, disposal, institutional controls, or a combination of these.

c) Applicable remedial technologies and process options will be identified and grouped by general response actions. Identified remedial technologies/processes will be initially screened based on technical implementability, and any alternatives determined to be technically infeasible will be eliminated from further consideration. Technologies selected for further screening will represent the most appropriate candidate methods for containment or extraction and treatment of contaminated soil and groundwater at the sites proposed for remediation.

d) Operable units will be defined by medium, contaminant type, site characteristics, and exposure pathway in order to provide a logical division of site contamination problems. Remedial action objectives, general response actions, and remedial technologies will be grouped by operable unit.

Step 2. Remedial Alternative Screening

a) Remedial technologies selected for screening will be further defined by better quantifying the areas and volumes of affected media and the sizes and capacities of the process options that make up the alternatives. Defined alternatives are evaluated using site characterization data, specific remedial action objectives, and other information available at the time of screening. The screening of alternatives is based upon three evaluation criteria: effectiveness, implementability, and cost. Alternatives with the most favorable composite evaluation of all factors would be retained for further consideration during the subsequent detailed analysis.

b) There may be insufficient data to adequately evaluate one or more remedial alternatives. All data gaps preventing a complete evaluation of the technology will be documented and supported by the identification of any environmental testing or treatability studies needed to determine the effectiveness of the remedial technology under site conditions.

c) An Informal Technical Information Report (ITIR) will be prepared detailing the development and screening of the alternatives process, and will identify the alternatives selected for detailed analysis.

Step 3. Detailed Analysis of Alternatives

a) Each remedial alternative will be further defined and evaluated based on effectiveness, implementability, and cost, using the nine criteria set forth in the in USEPA OSWER Directive 9355.3-01, Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA.

b) A sensitivity analysis will be conducted to assess the effect of varying specific assumptions, such as uncertainty regarding site conditions, the effective life of the remedial action, and operation and maintenance costs.

c) A comparative analysis will be conducted to compare the relative performance of each remedial alternative. The comparative analysis is a qualitative assessment, describing the strengths and weaknesses of each remedial alternative relative to the others.

d) A summary of the detailed analysis of alternatives will be presented in the R & D report, submitted following task completion. The summary will include tables of the individual and comparative analyses that will be used in the technical report.

4.0 REPORTING REQUIREMENTS

This section describes the content and preparation of each of the reporting documents to be prepared for the Kotzebue LRRS RI/FS, as required by the SOW. Reporting documents, including research and development (R & D) status reports, informal technical information reports (ITIRs), technical reports, and decision documents to be prepared for Kotzebue LRRS are described in the following sections.

4.1 RESEARCH AND DEVELOPMENT STATUS REPORTS

Research and development (R & D) status reports will be prepared monthly to describe the technical status and progress of the project. The purpose of the R & D status report is to inform the Technical Project Manager (TPM) of the progress of the project and to justify the hours billed during the reporting period. The monthly progress report lists target and actual completion dates for each element of activity, including project completion, and provides an explanation of any deviations from the milestones established in the Work Plan.

4.2 INFORMAL TECHNICAL INFORMATION REPORTS (ITIRs)

All data gathered during the work effort at Kotzebue LRRS will be detailed into appropriate ITIRs as specified in the SOW, and will contain all relevant portions as detailed in the *IRP Handbook*. ITIRs to be prepared for Kotzebue LRRS include the following:

- Analytical Data ITIR--The Analytical Data ITIR will include the analytical results, sample identification cross-references, a summary of extraction and analysis dates, and a quality control report.

- Site Characterization Summary ITIRs--The purpose of this ITIR is to provide a comprehensive description of the site-specific environmental characterization, including a description of the site conceptual model, information described in the Analytical Data ITIR, the nature and extent of contamination, and the interpretation of all data associated with each individual site.

- Screening Alternative ITIR--The purpose of this ITIR is to identify general response actions and applicable technologies based on site and contaminant conditions, and to combine technologies to formulate distinct alternatives. The development and screening of alternatives and the identification of alternatives selected for detailed analysis will be incorporated in this ITIR.

- Detailed Analyses of Alternatives ITIR--The purpose of this ITIR is to conduct a detailed analysis of each alternative selected in the Screening Alternative ITIR. Each alternative will be evaluated using the methodology established by U.S. EPA OSWER Directive 9355.3-01. In addition to the individual assessment, a comparative analysis will be performed to determine the relative performance of alternatives.

4.3 TECHNICAL REPORTS

Technical reports prepared for Kotzebue LRRS will include the Remedial Investigation (RI) Report, Risk Assessment (RA) Report, Feasibility Study (FS) Report, and the RI/FS Technical Report integrating the RI, RA, and FS information. All technical reports will be prepared as outlined in the *IRP Handbook*.

4.4 DECISION DOCUMENTS

The purpose of the decision document is to summarize the U.S. Air Force rationale for selecting a particular remedial action. Remedial actions reviewed will include the evaluation of a No Further Action alternative. The decision document is used to formally document remedial alternative selection by ensuring appropriate Air Force, state, and federal agency coordination and concurrence. Decision

Documents will be prepared in accordance with IRP guidelines (i.e., *IRP Handbook* and NFRAP Guide) and with the modifications necessary to satisfy appropriate ADEC requirements.

4.5 BASEWIDE COMPREHENSIVE IRP DOCUMENT

The purpose of the IRP Document is to develop a comprehensive summary of historic and projected IRP activities to be used as a management tool to effectively guide future IRP activities. The IRP document will be updated appropriately as new information becomes available, and will serve to supplement the Management Action Plan (MAP). The development of the Kotzebue LRRS IRP Document is based on direction provided by the AFCEE contracting officer representative.

4.6 INSTALLATION RESTORATION PROGRAM INFORMATION MANAGEMENT SYSTEM (IRPIMS)

Data generated during the RI/FS effort at Kotzebue LRRS will be incorporated into the IRPIMS database program. The most recent Contractor Data Loading Tool and QC Tool Program will be used for the IRPIMS deliverable in conjunction with Tetra Tech Inc.'s Standard Operating Procedure (SOP) derived for this task. The SOP includes instructions regarding data review for consistency and status, maintenance of magnetically stored data to ensure integrity, plus the internal review process for the IRPIMS deliverable. The final IRPIMS deliverable to the U.S. Air Force will be analyzed by the QC Tools Program to verify that the deliverable is 100 percent error free.

5.0 PROJECT SCHEDULE

The master schedule prepared by Tetra Tech, Inc. for the Kotzebue LRRS IRP RI/FS was developed based on key activities and deliverable dates identified in the SOW. Figure 5-1 presents the Kotzebue LRRS project master schedule, which provides milestones and deliverables that are updated on a quarterly basis.

Due to the remote location of Kotzebue LRRS, detailed scheduling for logistics and strategy are required to assure successful completion of the RI/FS field activities during the summer 1994 field season. Figure 5-2 presents a detailed schedule for the proposed RI/FS field activities at Kotzebue LRRS. The proposed field activities schedule was based on the following assumptions:

- Three to four Tetra Tech field personnel will be present onsite for the duration of the field sampling effort.

- Tetra Tech assumes a maximum work-day length of 12 hours.

- In general, Saturdays will be non-working days. Established non-working days may be modified based on the progression of scheduled work tasks.

- All samples will be collected between Sundays and Thursdays. No field samples will be collected on Fridays or Saturdays. This will insure good connections between flights transporting samples to the analytical laboratory, and allow for sample receipt during regular laboratory hours.

- Tetra Tech anticipates that four scheduled Alaska Airline flights will be leaving from Kotzebue for Anchorage on weekdays during the field season. Presently scheduled flights arrive at the Kotzebue Airport at the following times: 9:24 AM, 10:45 AM, 5:25

PROJECT: LRRS

IRP RI/FS KOTZEBUE LRRS

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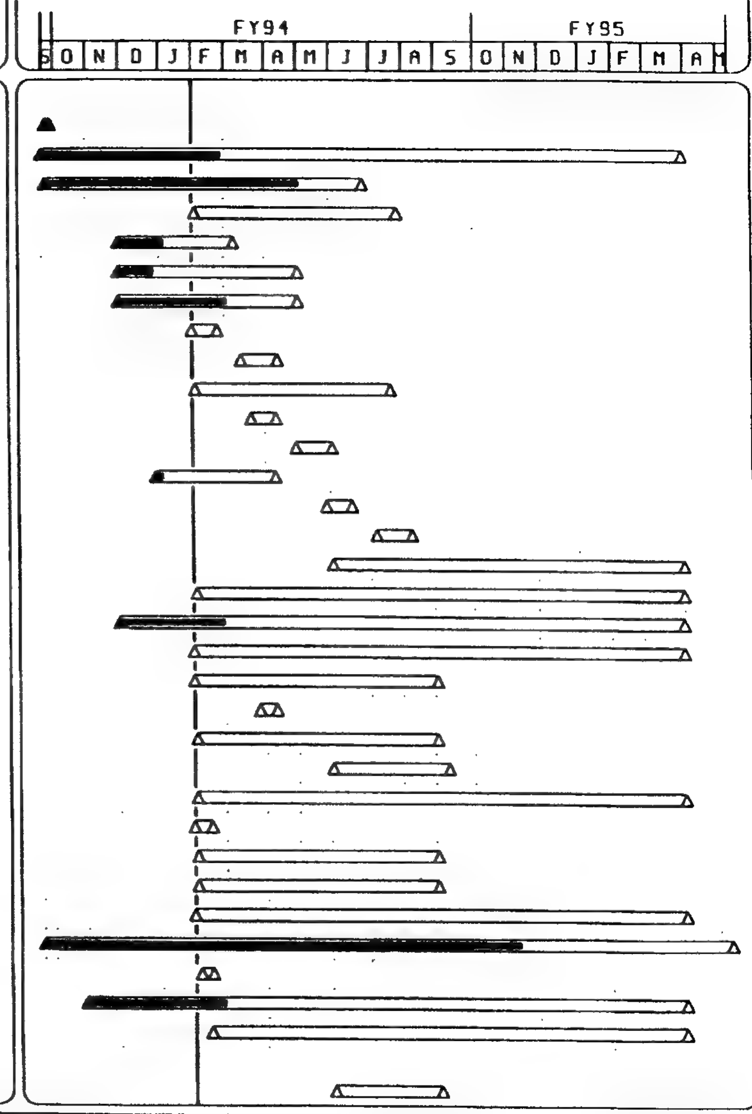
ACTIVITY DESCRIPTION	START	COMPLETE
PRE-FIELD SAMPLING ACTIVITIES		
Presurvey	27SEP93	01OCT93
Engineering Network Analysis	24SEP93	01APR95
Literature Search	27SEP93	27JUN94
Regulatory Requirements and Permits	03FEB94	27JUL94
Work Plan (WP)	29NOV93	07MAR94
Sampling and Analysis Plan (SAP)	29NOV93	02MAY94
Health and Safety Plan (HASP)	29NOV93	02MAY94
AFCEE Review Draft (WP, SAP, HASP)	31JAN94	21FEB94
AFCEE/ADEC Review (WP, SAP, HASP)	14MAR94	14APR94
Treatability Study Work Plan (TS)	03FEB94	21JUL94
AFCEE Review TS Work Plan	23MAR94	13APR94
AFCEE/ADEC Review TS Work Plan	01MAY94	31MAY94
Community Relations Plan (CRP)	30DEC93	12APR94
AFCEE Review CRP	27MAY94	17JUN94
ADEC/AFCEE Review CRP	09JUL94	08AUG94
Special Notification	01JUN94	01APR95
Presentation Materials (As Requested)	03FEB94	01APR95
Meeting Summaries	29NOV93	01APR95
Newsletter (As Requested)	31JAN94	01APR95
Fact Sheets (Quarterly)	31JAN94	30AUG94
AFCEE Review Fact Sheets	29MAR94	12APR94
Public Notices (As Requested)	03FEB94	30AUG94
Photo Notebook	31MAY94	09SEP94
Mailing List (Quarterly)	03FEB94	01APR95
AFCEE Review Mailing List	31JAN94	14FEB94
Maps (As Requested)	03FEB94	30AUG94
Public Information Poster(As Requested)	03FEB94	30AUG94
Information Repository	31JAN94	01APR95
IRP Document	24SEP93	10MAY95
AFCEE Review IRP Doc.	05FEB94	14FEB94
R&D Status Report (Monthly)	30OCT93	01APR95
Data Management (IRPMS Data ITIR)	14FEB94	01APR95
FIELD SAMPLING AND ANALYSIS		
Field Sampling	01JUN94	01SEP94



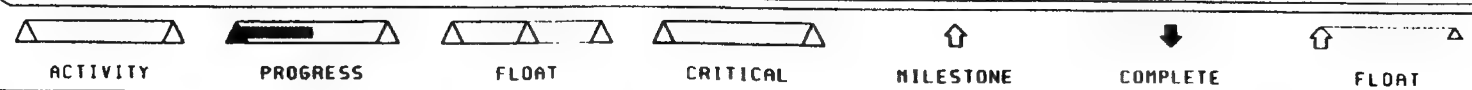


Figure 5-1. Kotzebue LRRS RI/FS Master Schedule.

PROJECT: LARS

IRP RI/FS KOTZEBUE LRRS

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ACTIVITY DESCRIPTION	START	COMPLETE
Geophysical Survey	01JUN94	01SEP94
Treatability Study	01JUN94	01SEP94
Laboratory Analysis	15JUN94	15SEP94
Data Validation	15SEP94	01DEC94
POST FIELD WORK		
RI Report (RI)	08SEP94	01MAR95
AFCEE Review RI Report	30NOV94	21DEC94
ADEC/AFCEE Review RI Report	11JAN95	09FEB95
Risk Assessment (RA)	29JUL94	01MAR95
AFCEE Review RA	01DEC94	21DEC94
ADEC/AFCEE Review RA	11JAN95	09FEB95
Feasibility Study (FS)	01SEP94	03APR95
AFCEE Review FS	04JAN95	24JAN95
ADEC/AFCEE Review FS	13FEB95	14MAR95
RI/FS Report	30MAY94	03APR95
Decision Document (DD)	01DEC93	02AUG94
AFCEE Review DD	30DEC94	20JAN95
ADEC/AFCEE Review DD	10FEB95	14MAR95
Screening Alternatives ITIR	29NOV93	09MAY94
AFCEE Review Screening Alternatives	28FEB94	21MAR94
Detailed Screening of Alternatives ITIR	28FEB94	21MAY94
AFCEE Review Detailed Screening Altern.	10APR94	30APR94
OPM Scoring ITIR	03FEB94	01MAR95
SCS ITIR	01OCT94	15FEB95
AFCEE Review SCS ITIR	30NOV94	21DEC94
Mylar Map ITIR	31JAN95	01MAR95
Geophysical Survey Map	01NOV94	01MAR95
Weekly Field Activity Report	01JUN94	10SEP94
Treatability Study Report	01NOV94	01MAR95
AFCEE Review TS Report	15JAN95	10FEB95

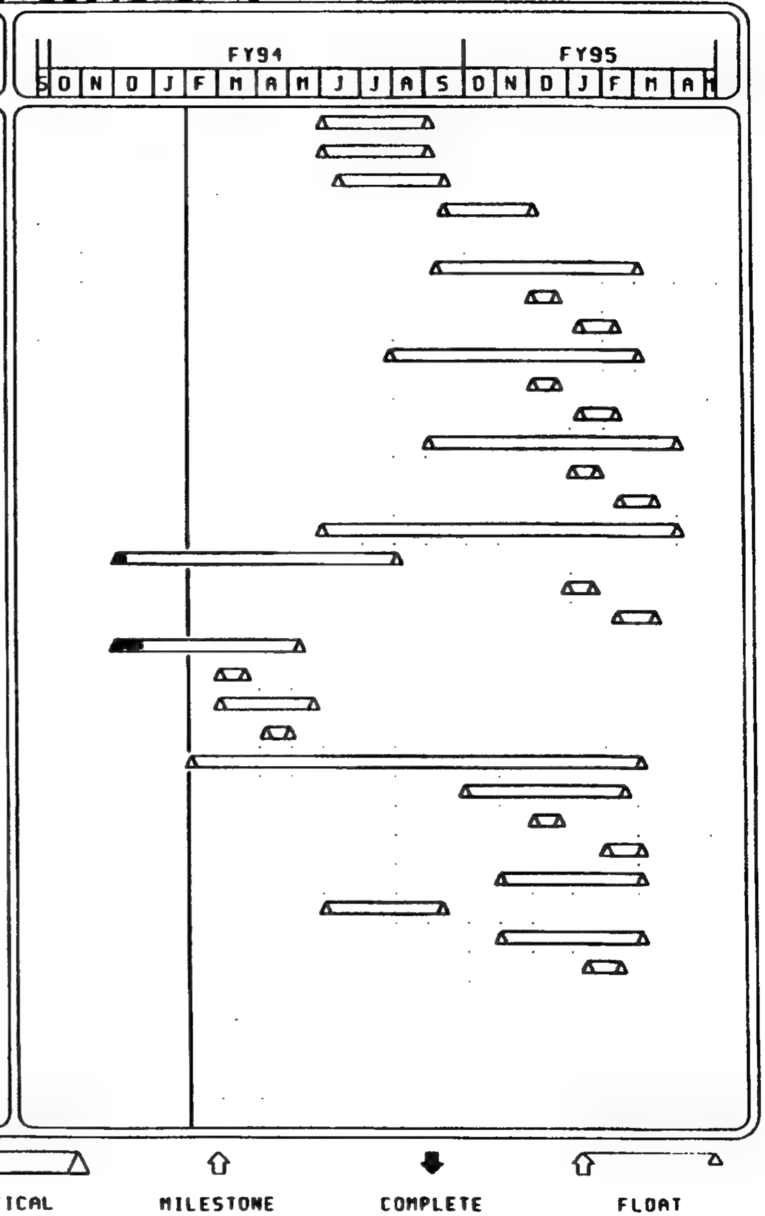

Figure 5-1. Continued

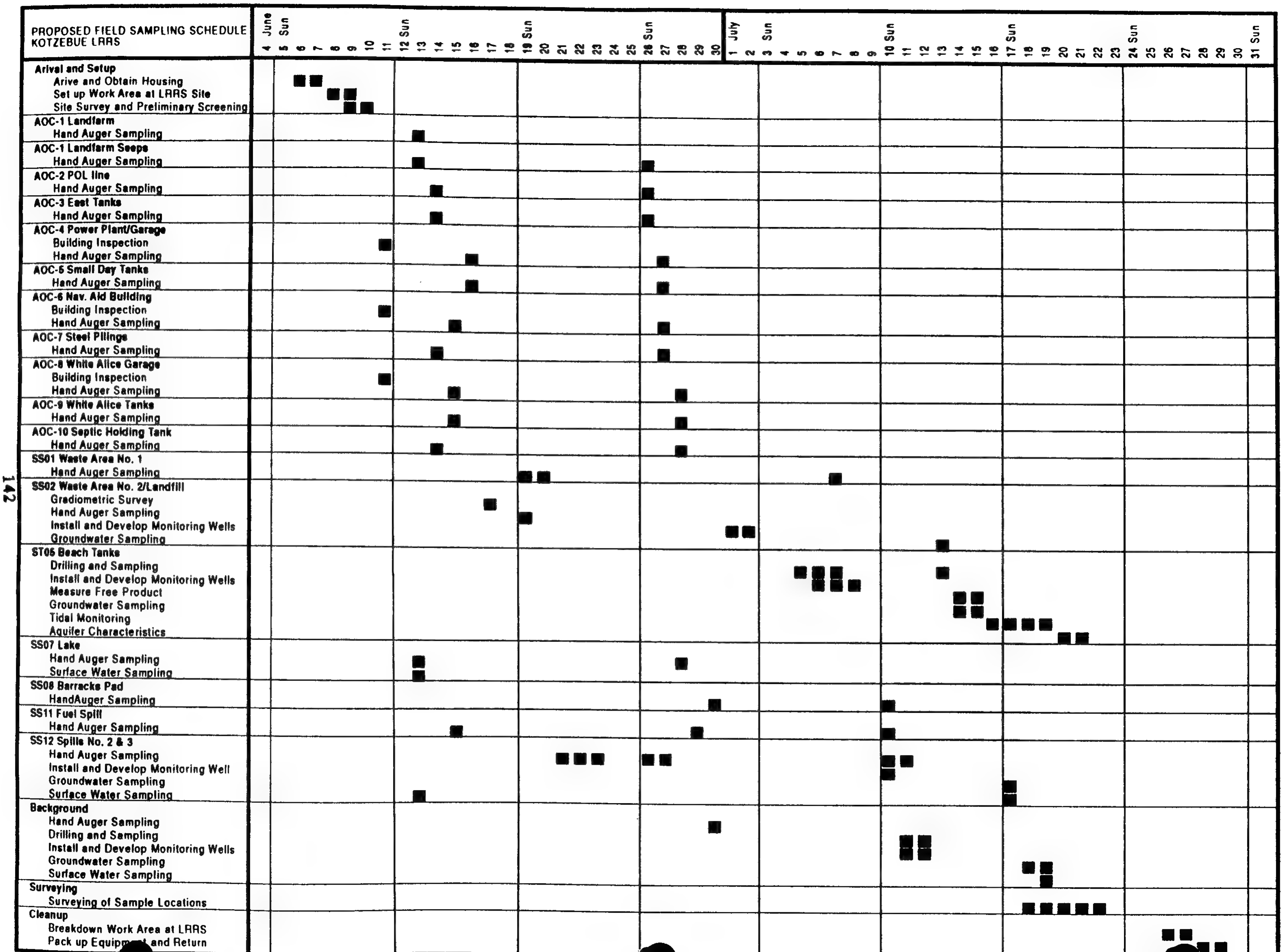

Figure 5-2. Proposed 1994 Field Sampling Schedule, Kotzebue LRRS.

PM, and 9:09 PM. A new summer flight schedule will be available in April or May 1994. Schedules for connecting flights will also be established at that time.

- The proposed schedule does not allow for lost time due to bad weather, broken drilling equipment, injury, or the presence of dangerous animals onsite. Although the field operations schedule includes some flexibility, unforeseen circumstances may extend the duration of the proposed field activities.

- Although the presence of shallow permafrost is expected at the site, the schedule as presented does not accommodate delays caused by frozen ground. Should frozen ground prevent the use of hand augers for sample collection in the early weeks of the field season, field tasks will be rescheduled.

- Tetra Tech assumes that contact with on-site personnel, or with community leaders from the Kotzebue area, will provide sufficient information regarding the depth to permafrost in the area as the field season approaches. The scheduled starting date may change based upon these conversations.

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